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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 285, 304
The Mechanics of Flight and Aspiration (*illustrated*)..... 286
A Triangulation System for River Surveying (*illustrated*)..... 288
Lining the Boulder Tunnel (*illustrated*)..... 289
The Stadia Method for Preliminary Railway Surveys..... 289
Mineral Production per Second in the United States (*illustrated*)..... 291
A Device for Recording Bridge Deflections and Vibrations (*illustrated*)..... 291
Water Power Electric Light Station, Guadalajara, Mexico (*illustrated*)..... 291
Schenectady Freight Locomotives at the World's Fair (*illustrated*)..... 297
Railway Cars at the World's Columbian Exposition 297
The Interstate Commerce Commission's Statistical Report..... 299
The New York Central's Standard Steel Rail Specifications..... 300
Recent Papers on Foundation Construction..... 301
PERSONALS, PUBLICATIONS RECEIVED, SOCIETY PROCEEDINGS..... 302
EDITORIAL NOTES..... 294
Engineering Headquarters at the World's Columbian Exposition—Economy of the Triple Expansion Engine—Double-Headed Trains on the Michigan Central Ry.—Block Signals in America—An Important Engineering Discovery.
EDITORIALS..... 294
The Soaring Power of Birds.
An Error of the Canadian Census.
LETTERS TO THE EDITOR..... 296
Concrete Bridge Piers—A Weak Floor Construction.
CONSTRUCTION NEWS..... 301, 304
Railways, Street Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.
INDUSTRIAL NOTES..... 304

The storm which swept the Gulf coast on the night of Oct. 1 proves to have exceeded in the extent of its devastation even the fearful storm which desolated the Sea Islands on the South Carolina coast two months ago. The New Orleans "Times Democrat" of Oct. 5 reports over two thousand deaths on the Louisiana coast alone; and the storm was severe all along the Alabama and Florida coasts as well. The storm seems to have been similar to that which visited the South Carolina coast. The low islands on which the fatalities chiefly occurred were inundated by the high tide which accompanied the storm, and the combined forces of wind and water speedily wrecked the frail dwellings.

The Mitchell Ave. tunnel under the Miami & Erie Canal, at Cincinnati, O., gave way Oct. 3, and the rush of water and debris caused considerable damage before the water was shut off at Lockland. The tunnel was built by the County Commissioners and was completed in 1879 at a cost of about $70,000. The arch was 65 ft. span, with six brick rings and cut stone portals. It is reported that about eight years ago a large section of the bank just below the tunnel gave way, necessitating the building of an aqueduct over the tunnel. This was made of heavy timbers and covered with planks, forming a trough. Earth was then banked up at the sides covering the timbers. This has been destroyed by the accident.

An electric car at Cincinnati, O., was struck by an express train at the Elmwood crossing of the Cleveland, Cincinnati, Chicago & St. Louis R. R. One person was killed, and six were injured.

The "Lucania," of the Cunard Line, has made the westward trip on her second voyage in 5 d. 13 h. 25 m. This breaks the previous best record of 5 d. 14 h. 24 m. made by the "Paris" in October, 1892. In the last 10 years the following best westward passages have been made by several of the steamship lines:

1884,	America, National Line.....	6 d. 15 h. 41 m.
1888,	Alaska, Guion Line.....	6 d. 20 h. 20 m.
1891,	Teutonic, White Star Line....	5 d. 16 h. 31 m.
1892,	Umbria, Cunard Line.....	5 d. 22 h. 7 m.
1892,	Paris, American Line.....	5 d. 14 h. 24 m.
1893,	Lucania, Cunard Line.....	5 d. 13 h. 25 m.

The old drawbridge of the N. Y. Central across the Harlem River was abandoned on Oct. 8. The lift-bridge, 250 ft. west of the old draw, will accommodate the traffic until the new and higher four-track drawbridge is completed, which will be in about 18 months.

Cornell University celebrated, on Oct. 7, the first 25 years of its existence, the chief orator being the Hon. Chauncey M. Depew. President Schurman said that during this period its productive capital had increased from $735,000 to $6,100,000, and there are 28 buildings, worth, with their grounds and equipment, $2,500,000 more. The income of the university in 1892-93 was $502,000, and the institution now has 150 professors and instructors, 1,700 students, and a library of 150,000 bound volumes and 27,000 pamphlets.

Howland & Ellis, civil engineers and contractors, of Boston, Mass., have obtained damages from individual members of an investigating committee appointed by the town of Maynard and from others for circulating the report made by the committee.

The trouble arose in 1889, concerning the execution of a contract between Howland & Ellis and the town named. The committee appointed to investigate made a report reflecting upon the character and business standing of the contractors, and the suit followed against the town and the committee individually. The case has been tried several times, and last week the defendants in the five last cases confessed judgment in favor of Howland & Ellis.

A test of 8-in. and 10-in. Holtzer armor-piercing projectiles manufactured by the Midvale Steel Co., of Philadelphia, was made at Sandy Hook on Oct. 6. Five shots were fired against 9 in. and 11¼ in. open hearth steel armor. The 8-in. shells weighed 300 lbs., and the 10-in. weighed 575 lbs. The lengths of the shells were 28.3 ins. and 35.2 ins., and the cost of each, as stated to the press, was $140 and $290. With 98 lbs. of brown prismatic powder the first 8-in. shell cut clean through the 9-in. plate; the second and the third did the same, the last shot being dug out of the sand with its point bright and uninjured. The 10-in. shell was fired at a double plate, 11¼ ins. in total thickness, with a powder charge of 160 lbs. 9 ozs. The first 10-in. shot went clean through plates, butt and backing; but the second 10-in. shell was deflected upward and fell into the sea. The trial was reported as highly satisfactory and proving the efficiency of the American-made projectiles.

World's Fair statistics, found in the last report of Director-General Davis to the National Commission, can be tabulated as follows:

Total number of separate buildings.....	400
Total area of 46 main structures, sq. ft.....	6,603,303
Statement of money raised for purposes of the Exposition, exclusive of cost and value of exhibits:	
Appropriated by foreign governments.....	$6,571,529
Contributed by States of the Union.....	6,020,850
Original appropriation by U. S. Government.	1,500,000
From U. S., 5,000,000 souvenir coins.....	2,500,000
From U. S., for bronze medals and diplomas	103,000
From U. S., for Government Board.....	550,000
From U. S., for National Committee.....	346,875
Receipts from stockholders.....	5,553,700
From City of Chicago.....	5,000,000
Six per cent. debenture bonds.....	4,094,500
Gate receipts to April 1.....	234,853
Interest.....	88,963
Miscellaneous receipts.....	295,504
Grand total raised.....	$33,248,930

Mr. Davis makes no reference to the large floating debt which was lately extinguished, nor does the report give any receipts since April 1. According to the latest press statistics the total of paid admissions to Oct. 9 inclusive was about 17,200,000, or say $8,600,000. The sums received from concessions do not pay the running expenses.

The most serious railway accident of the week was a head collision, Oct. 7, near Keats, Neb., on the Chicago, Rock Island & Pacific Ry. A westbound passenger train and eastbound freight train collided, owing to the failure of the operator at Manhattan, Kan., to deliver an order to the engineman of the passenger train. Two men were killed and three injured. The wreck caught fire, and the mail, baggage and several freight and coal cars were burned.——A Pennsylvania R. R. train ran into an open switch at Whiting, Ind., Oct. 10, causing the wreck of engine and mail car and the derailing of two Pullman cars. One man was killed and three were injured. The wreck caught fire, but the flames were extinguished by the local fire company.——A crossing collision occurred on the Boston & Albany R. R. at Riverside, Mass., Oct. 4. A gravel train was crossing from track No. 1 to track No. 4 to get out of the way of an express train, and was run into by a slow passenger train on track No. 3. Some of the gravel cars were derailed, but no great damage was done and nobody was hurt. There is the usual conflicting testimony as to the sending out of a flagman to protect the gravel train.

A wooden highway bridge over Fishing River, at Excelsior Springs, Mo., gave way Oct. 4, and two men were injured.——A county highway bridge over the Muscatuck River, at Seymour, Ind., was burned by incendiaries Oct. 5, involving a loss of $10,000.——A rear collision between two sections of a Louisville & Nashville R. R. freight train on the iron bridge over Pottinger's Creek, near New Haven, Ky., caused the collapse of the bridge, and two men were killed.

The Circle Railway, of Paris, belonging jointly to the five great French railways entering Paris, is 22 miles long, and has 27 stations. The "Journal des Transports" says that in 1892 this line carried 24,000,000 passengers, 4,000,000 tons of goods and 2,000,000 head of cattle; yet the total receipts failed to meet the expenditures by $120,000. The speed over this line is about 14 miles per hour. The same journal says that in 1892 no less than 293,794 trains entered and left the Saint Lazare station of the Ouest railway, or about 805 trains daily including Sundays. In London, the Waterloo, Liverpool St., and Broad St. stations average about 700 trains daily; though the Liverpool St. station is expected to operate 1,000 trains daily as soon as the new lines are completed.

The drainage tunnel for the Ontario mine at Provo City, Utah, is now 12,600 ft. long. Its total length is to be about 15,000 ft., and it is to be completed by May 1, 1894. On Aug. 14 a force began work at the mine end of the tunnel, and about 190 ft. has been driven. The completion of the tunnel will afford gravity drainage for all the mines on the lode and will put out of use the large and costly pumping plant.

Portland cement is being made at Tongshan, China, says the British Consul at Tientsin. The materials used are limestone, fire-clay, marl and a rough kind of China clay. The "wet process" is employed together with the most modern machinery. The fuel is hard coke made from the bituminous coal near by. The resulting Portland cement weighs 158 lbs. to the bushel, and the works have a capacity of 300 tons per week. The product is wholly used on the government works. The cement is guaranteed to stand a tensile strain of 400 lbs. per sq. in. after seven days immersion in water and usually tests higher than this.

The system of lighthouse illumination devised by Capt. P. A. Mahan, Engineer Corps, U. S. A., is to be tested on the lighthouses at Cape Charles and on Minot's Ledge. The plan of Captain Mahan is to give each light a distinctive characteristic by a series of flashes, so that the mariner can at once fix its location. The scheme was described and illustrated in Engineering News of Dec. 12, 1891.

A 40,000,000-c. p. electric light is to be erected by the French government on a projecting headland, 10 miles from Quimper. It will have a range of 150 miles in clear weather. This is double the power of the electric light lately set up at Cape La Heve, at the entrance to the port of Havre. In ordinary lamps of this class the lenses are arranged in steps and usually form about 12 panels to the circumference, thus greatly subdividing the source of light. At La Heve there are only four panels, and in the new light it is said there will be only two.

The City of Mexico has a rather poor water supply system, judging from a paper prepared for the International Engineering Congress by Mr. L. Salazar, and translated from the Spanish by Mr. Alfred F. Sears, M. Am. Soc. C. E. According to tradition water was first brought into the city in 1465 from two springs, the leveling for the aqueduct line being credited to Metzahualcoyotl. From time to time the supply has been increased from various sources, until in 1893 it is said to be about 12,000,000 gallons daily, the population by the census of 1890 having been 326,394.

In December, 1891, three 5,000,000-gallon English-built Worthington high pressure pumping engines were put in to raise a part of the supply about 100 ft.

The distribution system includes about 62 miles of mains from 80 to 8 cm., or 31.4 to 3.2 ins., in diameter.

The heading between East End and Shaft No. 1, on the Palisades tunnel, described in our issue of March 30, 1893, was "holed" at 11.50 a. m. Sept. 28. The distance from each portal to the point of "holing" is 973 ft. This was driven in 5½ months with four Ingersoll drills in each heading. The work on the heading was started eight months ago, but all work was suspended for 2½ months out of this period. Mr. P. F. McLaughlin was the superintendent in charge, and Mr. E. S. Safford was Resident Engineer. The contractors were Brodhead & Hickey.

An exhibition which is intended to reproduce some of the most prominent exhibits at the World's Columbian Exposition, and which is to be known as the World's Fair Prize Winners' Exposition, is to be held in the Grand Central Palace, New York city, from Nov. 24, 1893, to Jan. 13, 1894. The building is designed for trade exhibitions and similar purposes, and is situated on Lexington Ave., between 43d and 44th Sts. It is a six-story fireproof structure, 200 × 275 ft., with a floor space aggregating about 15 acres, and was only completed last spring. It is said that many applications for space have already been made by American and foreign exhibitors. The admission fee for the public has been fixed at 25 cts. There will be a restaurant, reading, writing and smoking rooms and an art gallery; and the top floor has been set apart for a "Midway Plaisance." Broad stairways and large elevators, with cars carrying 75 persons, will provide for the handling of large crowds. The exhibition will be held under the management of the Manhattan Industrial Exposition Co., 122 West 23d St., New York. President, R. G. Hollaman; Secretary, E. J. Crane; General Manager, Daniel Browne.

THE MECHANICS OF FLIGHT AND "ASPIRATION."

By A. M. Wellington, M. Am. Soc. C. E.

(A paper read before the Conference on Aerial Navigation, at Chicago, Aug. 1-4, 1893.)

In order that the phenomenon in the flight of birds, which, for lack of a better name, has been termed "aspiration," or rising against the wind by power taken from the wind, may be explained, it is presumably desirable to have a correct theory of the mechanics of flight. The theory which I have formed as to the latter differs in some important respects from any which to my knowledge has been suggested heretofore. Otherwise its several elements would seem to me so simple and so evidently true that they might almost be accepted as axiomatic. I shall state this general theory first, therefore, without attempting to establish it in detail, further than to say that, so far as I have been able to observe or ascertain, it is consistent with every recorded fact in regard to the flight of birds and inconsistent with none. In some slight degree the theory of the phenomenon of soaring and aspiration here given is in fact dependent upon this general theory of flight and therefore I deem it best to state it; but whether the latter be accepted or not, I hope to show that there is an easy explanation of the ability of the bird to rise against the wind through a considerable height, and to continue doing so indefinitely, especially by taking a spiral or zigzag course, and that the supposed mystery of that process, which has been ascribed to some peculiar power or shape of the wings, is really not such, but one much more easily explained and comprehensible.

By "bird" in this paper is meant only that large majority of birds which can maintain flight almost indefinitely if they continue in motion relatively to the air, to the exclusion of birds like the domestic hen which have imperfect or rudimentary flying powers, and of birds like the humming-bird, which have this power so highly devoloped that, like most insects, they can remain poised in still air at a single point by rapid motion of the wings. It is natural that this latter class, which is confined to quite small creatures, should need and should have much larger wings relatively to their weight than others, and perhaps too much has been claimed for the alleged law that wing ratios grow smaller as the bird grows larger, which is otherwise a most hopeful fact.

For all hopeful studies of the problem of aviation the following propositions should, in my judgment, be accepted as axiomatic. I state them as concisely as possible first, and add some explanatory remarks upon them afterward:

1. At no time and in no degree does any bird use its wings in normal flight as a means of propulsion. Their sole function in normal flight is to create an upward force of buoyancy or "negative gravity" which is approximately equal and opposite to gravity. According to the will of the bird this "buoyancy" (as it is hereafter called, for the sake of conciseness) is made a little more than gravity, when the bird rises, or a little less, when it descends.

2. This buoyant force is obtained in two ways, either by (1) flapping the wings in air which is still relatively to the bird (a temporary reliance requiring excessive muscular effort) or through which the bird is moving rapidly (requiring much less effort), or (2) exposing the wings as aeroplanes to air which is moving relatively to the bird, or (3) in part by both. By "soaring" is hereinafter understood such support by still wings moving through air, whether the bird be actually rising or falling at the time.

3. The propelling force of the bird is at all times either (1) a process of sliding downhill upon the air, when gravity is for the time being in excess, precisely as a sled slides downhill on ice, nearly horizontal motion being given by a vertical force, or (2) what is a precise mechanical equivalent, though reversed in direction, sliding uphill on the air, so to speak, when buoyancy is made to exceed gravity, either by flapping of the wings or by taking lifting force from the air in a way we shall shortly see. In many cases, as when a bird is flying with lazy flappings of the wings, it advances by a quick alternation of these modes of propulsion, sliding uphill as it flaps its wings, sliding downhill thereafter until the next flap. In other cases, when merely soaring and circling, it is propelled by the same alternation, as will be shown, sliding downhill with the wind and uphill against it, by natural action of physical laws.

4. The bird maintains its stability transversely in two ways, both easily imitated: First and chiefly, in the same manner as a ship is kept upright, by having the center of buoyancy considerably above the center of gravity. As a rule, the wings apply their support at about the level of the top of the back, and this alone seems to suffice for transverse stability in many birds, but in most birds it is supplemented by an upward inclination of the wings in soaring, giving them the form of a very flat V, so that any tendency to tip sidewise is checked by an increase of the supporting area on the descending side and a decrease on the other side. By these effective and easily imitated methods the transverse stability of the bird is maintained or increased without conscious effort.

5. The longitudinal stability of the bird is maintained by an action of forces strictly analogous to those which maintain the stability of the old-fashioned steelyard, the tail having, by insensible modifications of its angle to the body, the same function as the moving weight of the steelyard to maintain stability. In each there are only two main forces acting, nearly equal and opposite to each other, viz., gravity downward, and the buoyancy or sustaining reaction upward. In both however, a small adjustable third force is necessary to maintain stability in a horizontal plane, which in the steelyard is obtained by the small weight which is moved in or out, and in the bird is obtained by giving a slight upward or downward inclination to the tail, against which the air reacts so as to give either an upward or downward balancing force as may be required. In normal soaring flight, motions of the wings, head, legs and body of the bird are neither needed nor used for maintaining stability, though they may be occasionally resorted to.

6. It is certain that in the living bird this slight motion of the tail for balancing is effected by an unconscious reflex action of the nerves and muscles, just as the (probably) much more complex action of man's nerves and muscles for balancing the body in walking takes place by reflex action without his taking thought. It is certain that if man's muscular motions for walking depended on his taking thought before each motion, he could walk only very clumsily and slowly, if at all; the process of thinking is too slow. It is equally certain that the living bird cannot take thought for each balancing motion, for like reasons. Much more is it certain, therefore, that all attempts at artificial aviation which leave it to man's brain to balance the aeroplane longitudinally by any mode of steering will be far too slow, and are foredoomed to failure. Yet, it is not known that this fundamental and crucial necessity for a successful flying machine has ever before been recognised. It is easily secured, it may be noted in passing, by electrical connections with a drop of mercury in a tube which may be set for any angle desired from time to time, since the balancing force, though it must be instantaneous and automatic in its action, may also be made extremely small. Thus, we will suppose the probable case that an otherwise successful aeroplane is liable at times to get a sharp pitch downward. It is not necessary for safety that this shall be instantly corrected. It is enough if the body plane (as hereinafter defined) instantly becomes concave on top so as to cause the aeroplane to move in the arc of a circle struck from a center above itself.

7. The sustention of the bird in the air when soaring depends primarily on three facts: (1) The air has mass and is in immediate contact with the bird, so that it is impossible for the bird to fall at all until and except as it causes the air immediately below it to move with it; (2) it is impossible for the bird to cause this air to move downward any faster than gravity alone would cause it to fall in vacuo, or even quite so fast; and (3) the velocity with which a body begins to fall is almost inconceivably slow. Though a body falls 16 ft. in one second, it falls only 0.16 ft. in 0.1 second, and only .0016 ft. in 0.01 second, or with a velocity of 0.16 ft. (2 ins.) per second. At 50 ft. per second (about 34 miles per hour) the bird passes over 6 ins. of solid undisturbed air in every 0.01 second. From the inertia of this air, which resists any sudden change in its line of motion, the bird derives the upward reaction which overcomes gravity. From this it follows that the principal sustaining force must come from the front edge of the aeroplane, and not from the back part, resting on disturbed air. From this, in turn, it follows that the ideal aeroplane should have a stiff and long front edge, and very little depth longitudinally. Thus invariably we find wings in nature. Most of the attempts at artificial aviation have done directly the contrary, apparently in the vain hope of securing by length alone longitudinal stability. On the contrary, length tends to make it impossible by prolonging too much the quick process of automatic recovery which is otherwise possible.

8. To derive any sustention from the back part of the wings, which rest only on disturbed air, the back of the wing should dip downward so as to be concave below, so as to follow up, and get a reaction from the descending air. That this reaction may be uniform at varying speeds, the rear part should be flexible and springy, so as nearly to straighten out at very high speeds, and by diminishing the angle avoid an excessive reaction. Thus invariably we find wings in nature; thus they have rarely been in attempts at aviation.

9. The concavity of the wings has another useful effect for maintaining stability. The buoyant force is applied a little in front of the center of gravity, thus tending to lift the head up and tail down. By the upward reaction against the back of the wings an opposite rotating force is created, tending to throw the tail up and head down. Thus, stability is almost assured by this concavity of the wings independently of the tail, though it is not apparent why this need be imitated in artificial aviation. The wing planes should be concave to make the air support uniform, but the tail plane alone may be relied on for maintaining stability.

10. Buoyancy in soaring appears to be obtained by having the plane of the wings at a very slight angle with the "body-plane," as we may term it, which latter may be considered to consist of the tail and of a plane equivalent in its effect on the direction of motion to the body of the bird. In a broad sense the wing-planes may be included as part of the body plane, it being understood that they are always at a slight angle therewith in normal flight. Though the body is of irregular outline, it is evident that there must always be a plane (or at least a surface which is approximately plane) which would give the same reactions as to direction of motion, and so tend to move in the same direction as the body does in moving through the air. The bird modifies the form, and hence the direction of motion, of this body-plane by reflex movements of the tails or wings, or both, and, so far as observation, reason and experiment can indicate, keeps the wing-plane always at a slightly rising angle from the body-plane. The bird assuredly has and exercises the power to vary this slight angle at will, as notably in stopping, when it largely increases it. Whether the bird varies this angle in soaring is much more doubtful, but probably it does somewhat. It may or may not be desirable to preserve the same power in a flying machine. Probably it is not desirable, and at most it can hardly be essential.

11. The bird's loss by atmospheric friction in moving through the air is probably so small as to be almost negligible, measured in feet of fall per mile necessary to maintain a given speed indefinitely. Its form and outer coating has doubtless been developed to give the least possible air resistance, whether from skin friction or atmospheric displacement, and can only be imitated, as it is most unlikely to be improved upon. The air resistance only of a railway train, which is very ill-shaped for this end, being, in my judgment, about $\frac{V^2}{500}$ only in pounds per ton for velocity in miles per hour, neglecting effects of oscillation and concussion, we should, in my judgment, be fairly estimating the total resistance to the motion of a bird at one-tenth as much, which for a velocity of 50 miles per hour gives only 1.28 ft. per mile as the "grade of repose" or rate of fall necessary to balance this resistance. Doubling or quadrupling this estimate it is still a small matter relatively to the forces to be now considered, and we neglect it, not as non-existent, but as not materially modifying if included, while simplifying by its omission, the computations which follow.

12. (Reaching now more directly the phenomenon

of aspiration, or of taking power from the wind and rising or flying in the face of it.) A body moving through space in any direction has in it a certain fixed amount of energy for a given velocity, which is such as would suffice to lift the body through the height through which it would have to fall (in vacuo, strictly speaking) to acquire that velocity. This height varies as the square of the velocity, being four times as great for twice the velocity, and is given in the following little table for each mile per hour up to 60, and thence for each 10 miles to 100. From this table it will be seen that,

Height in Vertical Feet of Lift Through Which the Energy due to any Given Velocity of Motion Through Space Will Lift the Body Against Gravity Before it Comes to Rest. (Being the Height (h), in Vertical Feet Through Which a Body Must Fall to Acquire any Given Velocity (V) in Miles per Hour. Formula, $h = 0.033145\ V^2$.

Miles per hour.	0	1	2	3	4	5	6	7	8	9
0	0.0	0.03	0.13	0.30	0.54	0.84	1.20	1.64	2.14	2.71
10	3.34	4.05	4.82	5.65	6.55	7.52	8.56	9.67	10.84	12.07
20	13.38	14.75	16.19	17.69	19.26	20.90	22.61	24.38	26.22	28.13
30	30.10	32.14	34.25	36.42	38.66	40.97	43.34	45 78	48.29	50.87
40	53.51	56 22	58.99	61.84	64.75	67.72	70.77	73.88	77.05	80.30
50	83.61	86.99	90.43	93.64	97 52	101.17	104.88	108.66	112.50	116.42
60	120.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
70	163.88	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	214.05	.....	.....	.....	.....	.....	.....	.....	.....	.....
90	270.90	.....	.....	.....	.....	.....	.....	.....	.....	.....
100	334.45	.....	.....	.....	.....	.....	.....	.....	.....	....

at what we may call the unit velocity of 20 miles per hour, this vertical height (which may conveniently be termed the "velocity head"), is 13.38 ft.; for 40 miles 53.51 ft., and so on:

It must be understood that the direction of motion does not matter in using this table, nor how that motion was obtained. Any body which is actually moving through space in any direction with a given velocity, and is in any way guided so as to do so, will of itself and without the aid of exterior force, rise against gravity for the height given in the table; and this vertical height will be the same (neglecting friction) whether the body takes a short vertical or a long oblique path for rising.

And finally, it must be premised that the phenomenon of continuous soaring, or motion for hours together without flapping the wings and frequent rising against the wind, never occurs except when a wind is blowing, and generally a considerable wind of 15 to 20 miles per hour. The best soaring birds, as, for example, the carrion crow, are comparatively poor fliers in still air, and are rarely seen in the air for any length of time except when a wind is blowing; but as the upper air is practically always in motion, this limits their flight only when they wish to remain near to the earth with an eye out for food. The multitudes of birds which do this in all tropical towns begin flying only with the wind, and stop flying with it, giving every indication so long as the wind blows that they find resting on their wings in the air rather easier than standing on their feet on solid ground. Whoever has not observed with care the air of careless, lazy ease with which these birds maintain their flight, has missed, perhaps, the best lesson in the art of aviation, and may find it less easy to follow the subjoined explanation of their motions.

We will suppose the wind to be blowing steadily at 20 miles per hour, and the bird to be, for the instant, moving with it, also at 20 miles per hour. Every pound of air has then stored in it 13.38 ft.-lbs. of energy—a practically unlimited store—and every pound of bird has stored in it the same energy.

Under these conditions the wings have no sustaining power except to delay descent like a parachute. If the bird were suddenly frozen stiff in that attitude and with no relative velocity, it would fall at once to the ground.

To keep on flying when in this condition (which can only obtain for the instant) the bird has choice of two main alternatives, and only two. It may turn against the wind, lose velocity and rise, or it may turn into or with the wind, gain velocity and fall. To continue on wing support it must do one or the other, so as to produce a current of air against its wings. It may compromise between the two by taking a more or less oblique course, but one or the other must preponderate.

We will suppose the bird chooses the latter course—to go with the wind. Shaping its path to any slope it likes, it has only to descend through a vertical height of 13.38 ft. or thereabouts (as will shortly be established beyond dispute) to be moving through the air with a velocity of 20 miles per hour, AND to be moving through space with a velocity of 40 miles per hour. The potential lift corresponding to this latter velocity is by table 53.51 ft. before the body comes to rest, and 53.51 — 13.38 = 40.13 ft., as the bird's potential lift before its velocity of motion again falls to the original velocity of 20 miles per hour. The bird, therefore, has only to make a quick (or slow) turn back again into the wind's eye, and before it again returns to its original speed it will rise (on any path chosen by itself) through 40.13 vertical feet, or to a point 40.13 — 13.38 = 26.75 ft. higher than it was in the first place. It has only to repeat this maneuver to rise as high as it likes, so long as the wind holds, and it is obvious that circling is merely a more natural and graceful way of performing this maneuver, either being merely an alternate going with and into the wind.

We will now close the apparent gap in this argument, as above noted. It may properly be asked: If the bird starts with only 13.38 ft. of energy in it, and falls only 13.38 ft. more, or 26.76 ft. in all, how can it possibly have stored in its body at the end of this operation 53.51 vertical feet of energy,

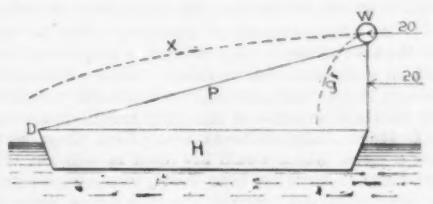


Fig. 1.

or any other number of feet in excess of 26.76 ft.?

The answer is: It takes this energy from the wind in falling through it and with it, and in a perfectly natural, simple and easily explained way, which only needs explanation because of our utter lack of practical acquaintance with the processes of flight. Because of this unfamiliarity, recourse must be had to more familiar conditions to make the process entirely clear.

In Fig. 1 let H be a floating hulk having erected upon it an inclined plane P, say, 13.38 ft. high, as heretofore, being the vertical head due to a speed of 20 miles per hour. Let this hulk and plane be moving horizontally at 20 miles per hour. Immediately above the top of the plane, barely touching but not fixed to it, let there be a spherical mass W, also at the instant moving horizontally through space at 20 miles per hour, and so for the instant at rest relatively to the top of the plane, but having its gravity resisted by it.

Now, if the hulk were fixed and stationary and the mass W also at rest where shown, there can be no doubt what would take place. The mass W would begin to roll down the plane and at the point D, at its foot, would have acquired the velocity due to the fall of 13.38 ft. = 20 miles per hour, and would be rolling ahead at that rate.

Similarly, under the conditions assumed, there can be no doubt what would happen to the mass W, except for the hulk and plane. It would begin falling in a parabolic path g, like any other projectile, according to well understood laws, and would strike the ground (or deck) with the velocity due to its original energy plus 13.38 ft. more of fall, being that due to 13.38 + 13.38 ft., being, by the table given, 28.28 miles per hour.

But under ALL the conditions assumed, what will take place depends upon a further fact: the relative mass of W and H-P. As to that we will assume two extremes; first, that the mass W is very great, and that the mass H-P, though having great buoyant power, is made of some as yet unknown material, and is very small in weight; and secondly, that the reverse conditions obtain, the mass W being very small and the mass H-P very great.

Under the first assumption it will be obvious that the great mass W will pursue its natural downward path g regardless of the trifling mass H-P, whose motions it will control to suit itself. In doing so it will absorb whatever energy there is in H-P, being thereby pushed out into a slightly longer parabolic path than its natural path g, and striking the ground with slightly greater force, having in the meantime brought H-P to rest; but sensibly its path will be unaffected. On the other assumption, that W has relatively trifling mass, it will still try to take the dotted path g, but the plane P will not permit it to do so. Instead of that, the plane P will wholly control W, and will keep pushing it ahead, pushing it ahead, as it descends, compelling it to take through space some much prolonged path x and all the time imparting successive installments of moving energy to it in order to compel it to take this path, until, when W has descended to the point D it will be actually moving through space with the velocity of (nearly) 40 miles per hour, because it will be moving relatively to the plane at 20 miles per hour. To acquire this additional energy represented by the higher velocity, it has, of course, had to take it from H-P, and by so much has decreased the velocity of H-P, but if the mass of the latter be very great relatively to W it will not have been sensibly decreased in velocity despite the large increase it has given to W.

In this latter instance we have a precise parallel to what takes place when the soaring bird is sailing with the wind, and this once clearly seen all mystery disappears from the process of aspiration, and everything that soaring birds are seen to do in air becomes easily explicable. I have not undertaken to write a long paper, and therefore cannot now follow through these maneuvers in detail, but it will be obvious that the mass and moving energy of the wind are practically infinite relatively to the bird's mass. The bird cannot diminish it by taking from it, and lateral friction keeps the mass of air in immedate contact with the bird moving synchronously with the adjacent air, regardless of the slight tendency to hold it back due to the bird's inertia.

All the recorded instances of circling and rising without work, such as that given in page 79 of Mr. O. Chanute's forthcoming work on "Flying Machines" (repeated in Fig. 2 herewith), are thus easily and completely explained. So also is the incident narrated on page 77, from Mr. Chanute's own

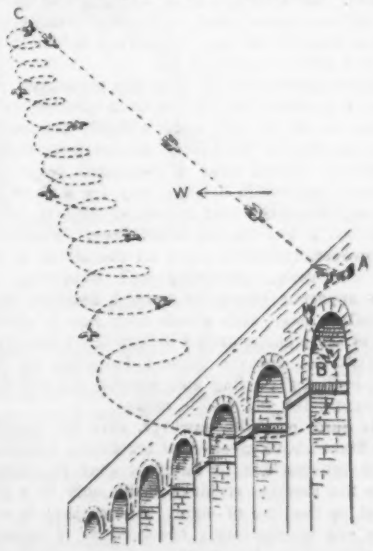


Fig. 2.

experience, where a gull spread his wings on top of a post in a wind of 14.4 miles (= 7 vertical feet of energy) and first "rose vertically 2½ ft." (equivalent work by the wind to giving the gull a velocity of 9 miles per hour), "then drifted back about 5 ft. still rising slightly" (equivalent to communicated work of, say, 10 miles per hour), "then advanced against the wind, losing a little height" (giving an impact velocity of, say, 16 miles against the wind), "and was thenceforth in full soaring velocity." (Which means that the bird first permitted itself to rise and drift back in order to gain height, and then gave a quick turn and went with the

wind to store energy in its body, for it could not possibly have risen into the wind's eye at the stated instant without thus first charging itself with energy, unless by some exceptional action like the following.

On the same page there is narrated a case where an eagle is said to have "first descended 7 to 10 ft. and then risen directly and slowly some 300 ft. into the air while advancing against the wind some 150 ft. into the air."

If this incident really occurred precisely as stated, as it easily may have done, it required a balance of forces analogous to Fig. 3 which is

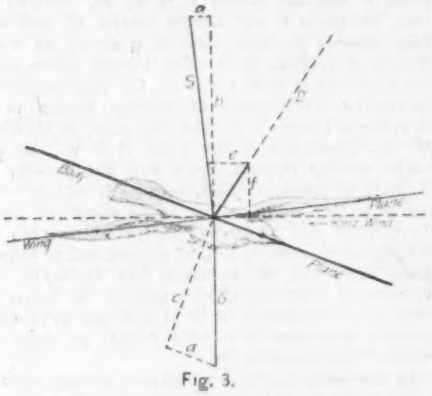


Fig. 3.

more difficult to explain with certainty, and which we may be sure is beyond imitation by man until the art of artificial flight has made great advances, since it must depend largely on quick reflex action of all the muscles, which circling does not. If the bird set its body-plane pitching forward at a (relatively) sharp angle, so that gravity (G, Fig. 3) tends to make it slide forward and downward, and then sets its wing-planes at a somewhat greater angle than usual to the body-plane, so that the reaction of the wind creates a buoyant force, S, greater than gravity, which is nearly all "lift" and very little backward "drift," we have the primary forces S and G, which may be resolved into opposing vertical and horizontal forces, as in Fig. 3. Canceling these opposing forces, so far as they are equal and opposite, we have left an unbalanced upward and forward resultant which will naturally tend to make the bird rise very slowly in the general direction D, as described. As shown, Fig. 3, requires the introduction of some other small force to give the required equilibrium, which may be derived in many ways, but can only be guessed at.

I have never observed just this maneuver, recognizing it as such, but I have often observed what I believe to be a still more difficult phenomenon, that, namely, of "hovering" almost motionless for a sensible period over a particular point. This can only be done in a wind, only for a short time, and only when the bird is headed directly into the wind; but it is certainly often done. While doing it, however, the birds have all the air of a tight-rope performer, quivering and balancing with much apparent effort, in marked contrast to the nonchalant ease with which they rise in circling. Both of these phenomena I believe to be mere tricks of balancing, forever beyond imitation by man, while ordinary circling and soaring are not so by any means, for any visible reason.

It is quite possible, however, that the record of eagle flight above given was erroneous, because of optical illusion due to the fact that the eye observes the motions of birds easily only in a plane normal to the line of sight. All motions in other planes are unconsciously observed as if projected onto that plane, the components of motion in a line to or from the eye being lost. What the eagle really did may have been to zigzag upward by pointing his head first into and then away from the wind. It is obvious that the alternations of velocity which we have found to be a necessity for soaring may be obtained as easily by zigzaging as by circling. The alternations will not be so great, nor hence the lifting force, but they may be obtained more rapidly and with less loss of distance.

For example, a flight in reversed arcs of 90° is only 11.1% longer than straight flight along the chord lines. If the latter be at an angle of 45° with (and against) a wind of 20 miles an hour and the bird maintains a steady motion of 20 miles per hour through the air, its velocity in space will be alternately 0 and 28.28 miles per hour, as a brief computation will show, giving abundant lifting force which the bird can use either to rise higher or to increase its velocity, as it will. At high flying speeds the arcs may be much flatter and still gain lifting force.

Only by the methods here given can the work done by good flying birds be explained. If the muscular effort were as great as indicated by many of the computations which have been put forward, a few hours of flight would burn any bird up completely, even if it obtains its power at the theoretically perfect rate of 0.18 lb. of carbon per horse power-hour.

If the conclusions so far reached in this paper be accepted, it is obvious that they greatly simplify the problem of artificial flight by reducing to a minimum the demand for power, making it chiefly necessary for acquiring the first initial velocity. All attempts at aviation which include any motor for propulsion, are, in my judgment, on wrong lines, and predestined to certain failure, since they not only neglect, but destroy, the action of the forces by which true flight may be and is attained. I will not go so far as to say that some birds in the exuberance of power may not use the wings to accelerate, as they do to retard motion. I think they do, but only in an abnormal way; it is wholly unnecessary and even destructive of all normal flight. The fish needs a propeller because it has no gravity in water; the bird does not need it because he has gravity, and in that gravity has the best and smoothest of all conceivable means of propulsion if he can make the wind lift him uphill whenever he has slid far enough downhill.

If so, man commits an absurdity when he flies in the face of nature and assumes a propelling force where none is needed or exists. Some other errors which, in my judgment, have foredoomed to failure all efforts at aviation so far made are the following:

1. Much disappointment has arisen from seeking a screw which would lift itself in still air. No experiments have yet been made, to my knowledge, to determine the vertical lift of a screw while it is at the same time being moved rapidly through the air horizontally. By mounting such a screw on the end of a long revolving arm, a surprising difference in vertical lift would be observed, I believe. If so, we may easily arrange to give any flying machine a horizontal motion of 20 to 40 miles per hour relatively to the air before lifting effort begins, and as lifting effort may stop as soon as a moderate velocity and any moving current of air is reached, the probable demand for power is greatly reduced below the present impressions.

2. The function of the tail as an automatic vertical rudder, and the absolute necessity of imitating the quickness of reflex animal motions by automatic mechanism, has been never before noted to my knowledge, and at least has been generally neglected.

3. So obvious a necessity as that the center of buoyancy should be at some considerable height above the center of gravity has been neglected in most of the prior attempts at aviation, as illustrated in Mr. Chanute's forthcoming treatise on the subject; yet every flying creature without exception may be observed to have this peculiarity.

4. The teachings of reason and nature in favor of making the supporting aeroplanes in the form of a flat V instead of a plane have usually been neglected. As the bird has the power of partly withdrawing the wing by reflex action it has less need of this form than man, yet nearly all birds carry their wings so in soaring.

5. There has been an inexplicable tendency to make aeroplanes long and narrow instead of wide and shallow after the analogies of nature. This, in my judgment, is a particularly grave error, because all or nearly all of the support comes from the front edge of the aeroplanes, resting on undisturbed air. All flying creatures have wings conforming to this theory.

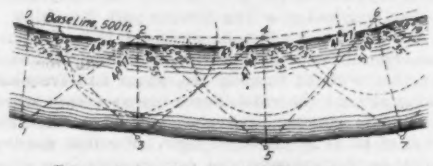
The greatest obstacle to making any real progress toward the art of aviation lies in the extreme difficulty and danger of making the first experiments. That difficulty can never be removed wholly, and until it has been sufficiently, clumsy errors of detail are inevitable in first attempts; but apart from that the problem in abstract mechanics, in my judgment, reduces itself to this: How to give an upward movement slightly in excess of gravity to an aeroplane imitating pretty closely the bird's form and weight per square foot of plane, and already having horizontal velocity, until a considerable height and tolerably steady current of moving air can be struck. That done, there seems to be no mechanical obstacle (other than lack of practice) why further lift and horizontal progress in any direction should not be continued indefinitely without further use of power, and why safe alighting without the use of power should not also be possible.

As the problem has interested me only in an abstract way, I leave to others the task of putting these conclusions to test; but that the problem is forever beyond man's power to solve, I see no reason to believe.

A TRIANGULATION SYSTEM FOR RIVER SURVEYING.*

By Walter G. Kirkpatrick, Assoc. M. Am. Soc. C. E.

For measuring the alinement of a river the following method has been found accurate and requires but little more work than the ordinary transit and stadia survey. In advance of the party, station "plugs," with tack centers, are driven along both banks, at distances about equal to the width of the river, those on one bank being opposite those on the other. The stations on one bank are numbered with even numbers, 0, 2, 4, 6, etc., and each should be visible from the next; locating them near the water surface lessens the clearing necessary. The stations on the other bank are numbered with odd numbers; these need not be cleared, except to be visible from the nearest three even-number stations. Station 1 is opposite 0, 3 opposite 2, etc. As a base line the distance is measured with a tape from 0 to 2, which, for this purpose, are conveniently located on a level bar. The transit



Triangulation Work on a River Survey.

is set up at each of the even-number stations and the angles measured between lines joining the instrument with the nearest five stations, two even-number and three odd-number stations. After occupying 30 or 40 stations a second base line is measured between two even-number stations, to check the computation. From this base line the computation starts anew, the work being continued as before and being closed on a third base line, and so on through the whole extent of the survey.

The Computation.—In the triangle, 2, 0, 3, having the side 2-0 and two angles known, the side 2-3 is found; then, in the triangle 2-3-4, similarly the side 4-2 is found. Successively in this way all the sides between even-number stations and those across stream are found till the closing base line is reached, when its computed length should equal its measured length. This computation is made with great ease by the use of logarithms, the triangles being solved in a connected succession of sine proportions. By observing the succession of numbers designating the quantities used in the four computations, any number of similar computations may be written out without even the use of a diagram and arranged in tabular form thus, arithmetic complements being used for negative logarithms:

Station numbers.	Known parts.	Logarithms.	Computed sides.
2-0	500 ft.	2.698970	
2-0 3	40° 31′	9 812692	
2-3 0	45° 16′	0.148503	
2 3	.....	2.660165	457.3
2-3-4	42° 05′	9.826211	
2-4-3	43° 38′	0.161125	
4-2	.....	2.647501	444.1
4-2 5	4 ° 22′	9.852247	
4-5-2	43° 16′	0.164059	
4-5	.....	2.063807	461.1

Platting the system by chords is best, and such a complete check on the work is afforded that an error can hardly escape detection. The natural chords are found for all the angles read with the transit, also the chord for the supplement of the sum of the four angles read at each transit station; these supplements may be called the deflection angles for the transit line 0-2-4-6, etc. Having platted the line 2-0, an arc of about 180° is drawn; with 2 as a center and with the

*A paper read before the Engineering Association of the South, Nashville, Tenn., Sept. 14, 1893.

radius selected for platting 2-0 is produced toward 4 till it intersects this arc; from the point of intersection the chord of the supplemental angle is scaled along the arc, and on the corresponding radius the distance 4-2 is scaled off, locating 4. Then, beginning at the point where 2-0 intersects the arc, the chords of the four angles measured at 2 are successively scaled off and the corresponding radii drawn; the distance 2-3 is scaled off, locating 3, and the distance 4-2 again locates 4, checking its former location. A similar process locates the four lines radiating from 4, from which the points 5 and 6 are located by scaling off 4-5 and 6-4; this process is continued through the work. It will be observed that, in advancing, every even-number station is located by platting the computed distance, or side, with a small supplemental angle and checked by platting the four angles; also that every odd-number station is located by platting the computed distance with an angle, about 90°, and is doubly checked by the two diagonals which must intersect each other at every odd-number station.

The facility with which this system of triangulation can be used comes from the fact that its operations are independent and can be completed in turn; it is easier to complete a hundred operations of one kind, then a hundred of another and another kind, than to carry forward all the groups at once. The station plugs are all set, then all the angles are read; in the computation all the column of station numbers is first written out, then all the corresponding angles taken from the field notes and put in the next column; all the logarithms of the known quantities are then found and put in the third column; then all the additions are made; and afterward all the lengths of computed sides taken from the logarithm table and put in the last column. In platting, all the chords are found and may be written in the fieldbook; finally the chain of platting is done, and the whole work may be rapidly advanced by a small party.

The fieldwork is facilitated by reading all the angles in azimuth from the same fixed line; if, in starting, the azimuth of the first base line from the true meridian be found, at each new station the vernier may be oriented by a back-sight and the azimuth from true north can be read directly for each line throughout the survey, reading entirely around the circle, 0° to 360°; if, at the same time, the compass box be read 0° to 360°, the needle gives an easy check on every azimuth. Stadia distances between stations can be read with but little additional effort, these serving to roughly check the computation as it progresses. For greater accuracy the two angles at each odd-number station may be read by the transit instead of being found by difference as above.

LINING THE BOULDER TUNNEL.

A paper read before the Montana Society of Civil Engineers by Mr. E. R. McNeill, and printed in the August number of the "Journal of the Association of Engineering Societies," contains an interesting account of the work of replacing with masonry the timber lining of the Boulder Tunnel, on the Montana Central Ry., between Helena and Butte, Mont. This tunnel penetrates a spur of the main range of the Rocky Mountains, at an elevation at the summit of grade of 5,454 ft. and is 6,112 ft. in length. Its alinement is a tangent with the exception of 150 ft. of 30' curve at the north end. The material penetrated is blue trap rock with seams for 4,950 ft. from the north end and syenitic boulders with the intervening spaces filled with disintegrated material for the remaining 1,160 ft. The dimensions and character of the old timber lining and of the new masonry lining replacing it are shown in Figs. 1 and 4.

The form of masonry adopted consists of coarse rubble side walls of granite, 13 ft. 8 ins. high, and generally 20 ins. thick with a full center circular arch of four rings of brick laid in rowlock form. When greater strength is needed the thickness of the side walls is increased to 30 ins. and that of the arch to six rings of brick.

The first plan adopted in putting in the masonry was to remove all the timbering; but owing to the large number of falls and slides this was abandoned and the plan now followed is to leave in the three roof segments of the timbering with the overlying cord wood packing and debris. In carrying on the work the first step is to remove the side timbers. This is done by supporting the roof timbers, as shown in Fig. 1; that is, the first and fourth arch rib of an 8-ft. section containing four arch ribs are supported by temporary posts. The intermediate arch ribs are supported against the downward pressure by 6×6-in. timbers, extending from the side ribs near the tops of the temporary posts to the opposite sides of the intermediate roof segments, as shown in the longitudinal section, Fig. 1. To resist the pressure from the sides, 4×6-in. braces are placed across the tunnel from near the center of the intermediate segments to the upper ends of the hip segments, as shown in the cross-section, Fig. 1. The hip segments are then sawed off below the notch and the side timbering removed and the masonry built.

The stone is conveyed into the tunnel on flat cars and laid by means of small derricks located on the cars. Two derricks are used, one for each side wall, and the work on both walls is carried on simultaneously.

The arch is built upon a centering, the ribs of

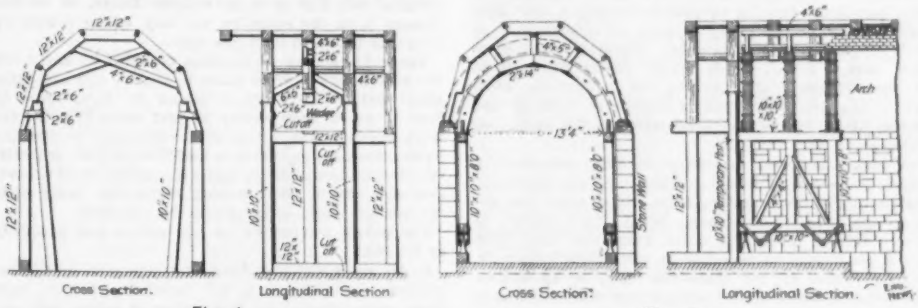


Fig. 1. Fig. 2.

DETAILS OF CENTERS AND METHOD OF SUPPORTING OLD TIMBER LINING. BOULDER TUNNEL.

which are 5½ ins. less in diameter than the distance between the side walls, so as to permit the use of 2¾ ins. lagging. Each center has three ribs, made of 1-in. or 2-in. board segments, 10 ins. thick and 14 ins. deep. These ribs are mounted on frames, which follow the opposite walls, and are 4 ft. apart, making the total length of the center out to out about 9 ft. The frames, upon which the ribs are supported, are shown in Fig. 2. As will be seen, they are mounted on dollys to enable the center to be moved from one section to another. Jacks are used to raise and lower the center into its proper position.

The arch is built up from the springing lines on both sides at the same time, four masons being employed. The rings are built beginning with the intrados, which is brought up, say, a distance of about 2 ft. from the springing line. Then the back of the ring is well plastered with from ⅜ in. to ½ in. of mortar and the second ring brought up to the same height and plastered on the back, and so on until the last ring is laid. After bringing the full width of the arch up some distance, new laggings are placed on the ribs for an additional height of 2 ft. and the same process is repeated. All the space between the extrados of the masonry arch and the old lining is compactly filled with dry rubble. When high enough so that the hip segments have a foot or more bearing on the masonry the segments are securely wedged and blocked up against the brickwork and the longitudinal 4×6-in. timbers removed. The remaining space is now clear for completion of the arch and both sides are brought up until there is not sufficient space for four masons to work, when the keying is completed by two masons beginning at the completed and working back toward the toothed end. The brickwork is built from the top of a staging car.

In a few instances where slides have occurred after the removal of the slide timbering the method of retimbering the tunnel, shown in Fig. 3, has been adopted. Two side drifts were first run 2½ ft. wide by 4 ft. high and the plate timbers placed in position and blocked. Cross drifts were then run and the roof segments placed, and the core down to the level of the bottoms of the side drifts taken out. The lower wall plates were then placed and the hip segments inserted. The bench was then taken down by degrees, the side plates being held by jacks, and the posts placed one at a time. As the masonry at the points where slides occur consists of 30-in. walls and six-ring arch the timbering was 22 ft. wide in the clear, with other dimensions as shown in Fig. 3.

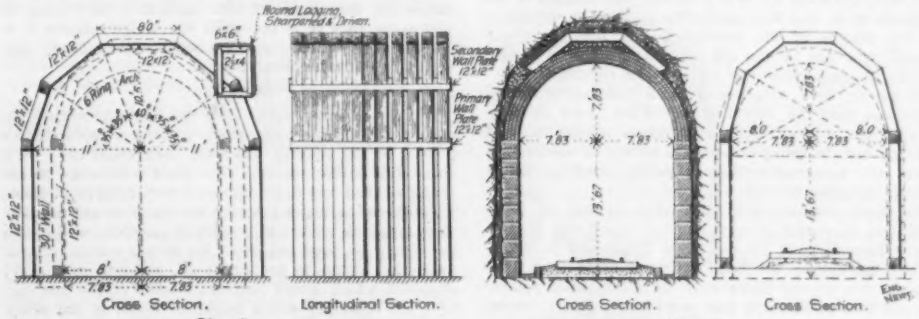


Fig. 3. Fig. 4.

SOFT MATERIAL TIMBERING AND MASONRY LINING, BOULDER TUNNEL.

Only a single crew of brick and stone masons is employed. In order to prepare the sections for these masons it is necessary to have timber and trimming crews at work throughout the whole day of 24 hours, so that an engine and two train crews have been in constant attendance. The single mason crews are able to complete 8 ft. of side walls and arch in 24 hours. The number of men actually employed at the tunnel is 35. This includes electric light maintenance, and all other labor pertaining to the work. The tunnel is lighted by an Edison dynamo of 20 arc light capacity, one arc light being placed on each side of the tunnel at all working places. Each lamp carries a coil of wire 20 or 30 ft. long to allow it to be shifted from place to place without delay. The work is being done by contract. During the year devoted to the work 1,600 ft. of tunnel have been completed, and about a year and a half more will be required to finish the work.

THE STADIA METHOD FOR PRELIMINARY RAILWAY SURVEYS.

In a paper read before the Civil Engineers' Club of Cleveland, and printed in the "Journal of the Association of Engineering Societies," Mr. James Ritchie describes briefly the use of the stadia rod in making the preliminary survey for a railway line about 46 miles long. The advanced position which the stadia method has attained in the last few years in general map and topographical work, together with its cheapness and rapidity, make its application to the preliminary survey of railway lines of much interest, and we abstract Mr. Ritchie's paper nearly in full and follow it with some of the more important parts of the accompanying discussion:

The railway line for which this survey was made extends from the harbor of Fairport, O., on Lake Erie,

about three miles from the city of Painesville, O., to a station on the line of the New York, Lake Erie & Western Ry., known as Phalanx, about 46 miles from Cleveland. The proposel line is about 46 miles in length, and is intended eventually to be continued to Youngstown, O., about 20 miles further. The object of the road is to provide another line for the transportation of coal and ore to and from the lakes, with such local business as may be developed along the line. The great point to be considered was to obtain as low a grade as possible with the least expenditure of money, and with as direct an alinement as could be obtained.

The first difficulty met with was the Lake Erie bluffs, which extend along the lake for its entire length, intersected and crossed by streams which form deep valleys, but which are so tortuous in their course that the idea of following them for their entire length is certain to greatly lengthen any line, and thereby increase the expense of construction as well as the cost of operation. These streams have also many falls, which would necessitate sudden changes of grade and prevent the maintaining of a low ruling gradient. This is especially true of the Grand River, at the mouth of which is the harbor of Fairport.

It was, therefore, necessary to start out with a heavy grade from the lake, intending to use a helping engine to the first summit, from which point one engine could haul the maximum train. This summit is near Chardon, about 12 miles from the lake. The heavy grade can be operated in two ways, either by using a pusher on the maximum train, or by having the terminal yards at the summit and taking the cars up and down by yard engines as they may be loaded, and making up the maximum train at the summit. The latter is probably the method that we shall adopt.

In October and November, 1892, a preliminary chain survey was run from the lake to Phalanx, and the profile showed that a grade of 26.4 ft. per mile could be obtained between Chardon and Phalanx, although the line surveyed, being only a preliminary, did not give any information outside of its own territory, excepting what was obtained by barometric observations taken in connection with it. The best grade that could be obtained north of Chardon was 66 ft. per mile, and this could not be obtained except by deviating from the surveyed line.

The writer has been connected with several railways, and on each one has endeavored to introduce the stadia method for preliminary surveys, but has always been met by the prejudices of his superior officers, who did not believe in the method or had never tried it and hesitated to do so. In this work it was decided by the writer to use this method in all surveys after the first preliminary, but, in deference to the wishes of his associates, one line, as above stated, was run by the old method. This was a good means of comparison also for cost and results.

It having been determined by a barometric reconnoissance that the best line would be found by way of Chardon, Burton, Troy and Nelson townships, and through certain valleys therein, a survey by stadia was made, the topography of each valley carefully determined and maps platted.

To those unacquainted with this method of topographical surveying it may be well to explain that it is the method used by the U. S. Engineers in filling in the topography between their points of triangulation. In this survey there were no triangulation points, but our first preliminary line served as a partial check upon our work, and the results satisfied the writer that the stadia survey was fully as accurate as the chain survey.

The best method of making a stadia survey is to occupy each stadia point, orienting the transit by setting the supplement of the forward angle upon the last station and turning off each sight to the right, reading the vernier from 0° to 360°, without transiting the instrument. This was adopted in all cases excepting on one line, which was surveyed as a line connecting two stadia lines and on which alternate stations were occupied, and the orientation performed by the magnetic needle, setting the 0 of the circle on the magnetic meridian. The sights were then taken to the rear and forward, and the results have more than equaled the writer's expectations; as the greatest variation from the preliminary chain survey at points of intersection was 20 ft. in distance, while the direction has never been appreciably out. The levels were carried on by the vertical angles, checking on the first preliminary as often as possible, the greatest error being 0.3 ft. The reductions were made in the office by the use of Johnson's tables, the main stadia points being reduced in the field so as to enable the necessary checks to be made as the work progressed and to see that the general level was in conformity to the desired grade.

For a description of the general theory of stadia surveying the members are referred to Johnson's work on "Topographical Surveying by Transit and Stadia," which fully and clearly describes the method and gives the tables, our only variation being that one of our stadia lines is a very carefully run compass line, instead of a transit line.

On the maps made from the stadia survey we have platted a location, and have made a profile of said location, which is fully as accurate as could be obtained in the field, and for an estimate of cost is far superior to any preliminary profile. This line can be reproduced on the ground by careful measurements, and the writer feels very confident that, except for the obstructions which right of way matters may cause, the line located from this map will show a profile and alinement the same or nearly the same as is shown on the profile made above. This line is about one mile longer than the first chain survey, or about 46 miles. In locating from this map there will be no backing up and changing, or running new preliminary, as is always the case under the old way, but we can reproduce this line as it is, without delays, or we can change it in the office as we may desire before attempting to locate it in the field.

The chain survey of 45 miles occupied 24 days; and the stadia survey of 46 miles in length, and averaging about 800 ft. in width, occupied 30 days, three or four of which were stormy in part so as to delay the work greatly. The estimate of earthwork on the line plotted from stadia survey is 1,341,508 cu. yds., or 30,000 cu. yds. per mile average, being calculated as all excavation and borrow, the necessary corrections being made for side-hill work, as shown by the contours.

The points determined by the survey are generally as follows:

1. All main stadia stations and side stations for extending topography. 2. All buildings, fences, land lines, roads, creeks, top and bottom of banks, and any knolls, changes in slopes or points which would indicate a change in shape of the contours, all these points being determined by the rod reading, horizontal angle, giving the distance, direction and difference of elevation from the point of observation.

The recorder makes all necessary sketches, marking the points observed on same by letters, and using the same letters in his notes. The stadia party consisted of a chief, a transitman, recorder and four or five rodmen. The location first plotted was not entirely satisfactory to the writer, although it gave a very good profile, but several changes in alinement have been made on the map, greatly reducing the curvature without materially affecting the work of construction. Another advantage is thus shown for this method of surveying, as no location work in the field will be commenced until the location shown on the map is satisfactory. It will be interesting to compare the profiles taken from the map location with that obtained by the field location; and that will still further demonstrate the usefulness of this method of surveying, or will show that it is not what the writer claims it to be, the most satisfactory method for preliminary surveys in a difficult country.

Discussion.

Mr. Hosea Paul stated that for the expenditure incurred Mr. Ritchie had certainly given a much clearer picture of the country traversed than could have been done with a line survey. One great advantage of the stadia method was the ability to depart from fixed lines. An engineer in making a line survey must get as near the ground he wishes to occupy as possible, while with the stadia he need not make his survey on the ground which he wishes to occupy at all, and can thus avoid obstacles which would occasion trouble in the line survey. An objection which might be urged is the temptation to too much elaboration and the danger of accumulating too much useless data. While paper locations were useful, he did not regard them as finalities. The time of the engineer should be largely spent on the ground, and the results reduced to paper from day to day and made available, otherwise errors of paper locations are certain to accumulate, especially in a very rough country.

Mr. William Searles said that he had never felt that stadia work was well adapted to original surveys, or any in which there was not at any rate a check upon it by some independent survey. The question is: How advantageous is stadia work in the preparation of the topographical map for the purpose of the paper location of a railway? The old method of locating a railway line was to blunder ahead and make the locations somehow on the ground without any map, and many roads have been so located; and years afterward, when they could afford it, they have been re-located; whereas, if the work had been done on paper before attempting to do it on the ground, the probability is that re-location would not have cost more than 1% of what it finally cost.

If the reconnaissance is carefully made, so that the engineer is tolerably sure of where the located line ought to be, he does not care very much about the topography right and left of that line to any wide extent; and then the method becomes simply driving a preliminary line on that fixed route, and making the width of topography just enough to include the work that is to be done in grading, or possibly show the effect of the road upon the neighboring property. But if the country is broken and rolling, then the stadia work comes in very favorably, and gives a wider range of view in making selections of our location; at the same time something is lost in precision on any one part of the line.

He had a feeling that in locating topography simply by points, viz., where the rodmen have stood, that much of the intermediate work was indefinite, and although it appears definite on the map it is, to some degree, inaccurate. Thus where the projected line runs intermediate on the map between two stadia stations the profile is likely to differ quite a little from the final profile, or from the reality obtained on the ground. It would be quite interesting to test the accuracy of these particular maps by the location map and profile, when they are perfected. His impression was, with all due respect to the gentlemen interested, that when the located map is completed this preliminary will be relatively worthless. That is to say, location being made by chain and transit with the usual care, topography sketched along the projected line will be found to differ to such a degree from the reality that these maps will be cast aside in favor of the new ones. His preference had been to study the ground itself carefully first, perhaps without instruments, so as to know very closely what was wanted, and then confine the work of the party to that line. In that way he had avoided using the stadia, although had no objection to it. It gives very good topography which often proves to be far outside of the right of way of the railroad. Theoretically it is a bad way to survey, because the triangles are so ill-conditioned. The legs of the triangles are several hundred feet long, and the base is only a part of the stadia rod. The part intercepted on the rod is so small compared with the distance from the instrument that if there is any error in the reading it becomes wonderfully magnified in its results on the distance.

He had found great discrepancies between stadia and accurate chain measurements, and it struck him that the method was not very accurate. The fault may have been in the man or the instrument; but on general principles it appeared that while small distances might be observed with considerable accuracy, it would not be well to undertake to locate points by inversion of the method; i. e., by observing the rod and motioning the man backward and forward until a certain reading was obtained.

In an open country not much wooded, Mr. Thompson considered that the stadia might be useful in filling in topography; but in a mountainous country, where the timber is heavy and close together and the ground much broken, a great distance on either side of the line is not required.

Speaking of paper location, his method was to take topography in the ordinary way with slope levels or other hand instruments. The level-man himself was expected to give much attention to the topography, and be able to answer every question except such as belonged especially to the transit. The location line is projected on the map of the preliminary line, on which the topography is drawn, the profile of the preliminary line being of course considered. He had, in exceedingly rough country, thoroughly wooded, seen location checked inside of 1 ft. in a distance of a mile. As the item of cost is a leading factor in the construction of railways the location is often, in thickly settled districts, made secondary to the question of right of way.

In regard to the accuracy of the stadia method, Mr. J. F. Brown stated that he had made some use of the stadia in the past two or three years in running random lines, in rough country, for locating a line; that is, in measuring a random from point to point over the knolls or hills. He ran one random 3,800 ft. long, and measured the distance with the stadia rod, and summed up the total; and after checking over the true lines by actual measurement there was only a difference of 0.13 ft.

He had also measured some dock lines where it was difficult to span the distance, and those distances had been carefully computed by the city engineer, and found on distances of 500 to 600 ft. the stadia would read down to within 0.03 ft. or 0.04 ft. of actual distance. He was satisfied that the stadia is more correct than the actual measurement for that kind of work. Running random lines 3,500 ft. long with the stadia saved half the work.

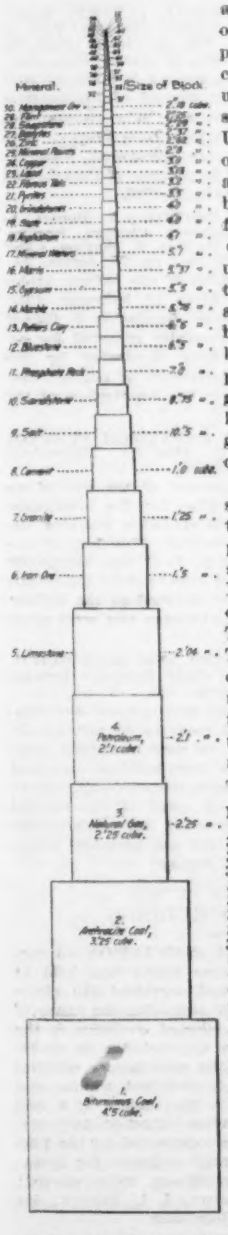
Mr. Porter stated that in preliminary work saving money is not the only object in view. He understood that the use of the stadia was to get the most information possible for the money expended. There was a certain amount of money to be used for making a preliminary survey, in a certain length of time; and the problem was to get the most information possible for this money. He had always thought the chances for error in stadia work were too large to warrant its use in accurate work, and almost thought so still. But there were cases where the stadia gave large results for small expenditure, both of money and of time.

In replying to some of the points brought out in the discussion Mr. Ritchie gave some further points of advantage in using the stadia. One advantage of the

method is that it gives a great deal more information for a given cost, and such information that, when it comes to location instead of running half a dozen preliminary lines in the field, all preliminary lines had been run on paper, and the location was known before the start. Another advantage is that all the accurate work that requires care is done by one man. In the chain survey there are two chainmen who have to be pretty careful. If they are not careful there is trouble. They may drop 100 ft., or hold the chain slanting; whereas in a stadia survey one man at the transit does all the work. Of course, the recorder has to keep his notes right; but it does not make so much difference what the rodmen are. They can be little better than ordinary laborers if necessary.

MINERAL PRODUCTION PER SECOND IN THE UNITED STATES.

The United States Geological Survey has a very striking statistical exhibit in the Mines Building, at the Columbian Exposition. The exhibit is located at the north end of the main aisle and consists of a series of cubes, piled on each other to form a pyramidal structure. Each cube represents the volume of some mineral substance produced in the United States in one second of time. The cube at the base is a block of bituminous coal and is 4 ft. 6 ins. square. Then come anthracite, natural gas and petroleum, the gas being shown by a block cut to the size of a block of coal which would be equivalent in heating power to the volume of gas represented. Petroleum is shown by a hollow glass cube filled with crude oil.



The accompanying cut shows an elevation, drawn to scale, of this interesting pyramid, which was designed by Dr. David T. Day, Chief of the Division of Mining Statistics and Technology of the Survey. The dimensions of the lower blocks and the material represented are shown on the cut. The material of the upper blocks and their relative size are given in the following table:

No.	Mineral.	Size of cube. Ins.
31	Borax	1.9
32	Feldspar	1.9
33	Fluospar	1.79
34	Infusorial earth	1.5
35	Chromic iron ore	1.15
36	Corundum	1.01
37	Sulphur	1.01
38	Millstones	.88
39	Novaculite	.77
40	Silver	.74
41	Ozocerite	.70
42	Quicksilver	.47
43	Bromine	.47
44	Graphite	.46
45	Antimony	.4
46	Aluminum	.35
47	Asbestos	.33
48	Nickel	.28
49	Mica	.27
50	Tin	.25
51	Gold	.177
52	Cobalt oxide	.096
53	Precious stones	.09
		Grains.
54	Rutile	.0576
55	Platinum	.009

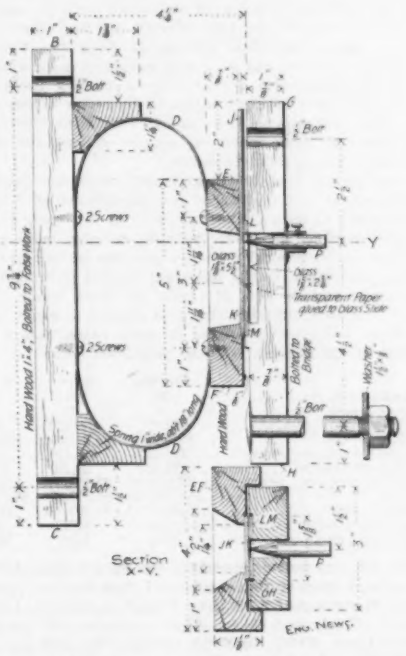
The table will be found useful for reference, as by multiplying any of the cubes by the constant 31,536,000 (the number of seconds in a year), the annual volume of production of the United States for each mineral in the list is readily ascertained.

A fact of much interest which the pyramid makes very evident is that our fuel supplies far outrank in bulk all other minerals combined. It is an eloquent testimonial to the extreme importance of fuel to our modern civilization.

A DEVICE FOR RECORDING BRIDGE DEFLECTIONS AND VIBRATIONS.

We illustrate in the accompanying cut a device for recording the deflection of railway bridges, designed by Mr. E. T. Thomas, of Hamilton, Ont., Bridge Inspector for the Canadian Pacific Ry. The construction and operation of the apparatus is as follows:

The board B C is fastened to a falsework, or post, unaffected by any motion of the bridge, and carries the steel spring D, to which is fastened a second board E F, with a hole in the center, as shown by the drawing. The glass plate J K is slipped into a groove in this board and has glued to its face a piece of tracing paper, upon which the deflections are recorded. The board G H is fastened to the bottom chord of the bridge and, of course, moves with the bridge. It is pierced with a hole for the pencil P and carries a glass plate,



Device for Recording Bridge Deflections and Vibrations.

which bears against the fixed glass plate J K, and reduces the friction. The spring D acts always to keep the two plates pressed together and thus keep the paper in contact with the pencil point. The diagram is made by the movement of the pencil caused by the movements of the bridge under the passing train.

As will be seen from the description, this is nothing but a somewhat elaborate and carefully constructed form of the apparatus long used for similar purposes on railways in this country. The chief objection to any device of this form is that the diagram obtained is a knotted tangle of lines which give the maximum deflection, but do not show the intensity and character of the vibrations caused by various parts of the moving load. A clockwork or other mechanism to give the paper a regular horizontal movement is necessary in order to secure the most valuable diagrams of deflections and vibrations. Apparatus for testing deflections giving a continuous diagram have often been used for special investigations, but we are not informed whether any railway company in this country provides its bridge inspectors with devices of this type for regular use. Perhaps some of our readers can give further information on this point.

WATER POWER ELECTRIC LIGHT STATION, GUADALAJARA, MEX.

The power station furnishing electric light to the city of Guadalajara, Mex., was described in a paper before the International Engineering Congress by Mr. Rafael M. de Arozarena. The power station is located 17 miles from the city, at the Juanacatlon Falls, on the Rio Grande River. The station equipment includes three 550-HP. double-horizontal Leffel turbines driving five Thomson-Houston alternating dynamos, four being 50-lamp arc dynamos and the other an incandescent lighter of 7,500 16-c. p. lamps capacity.

The river above the falls is wide and shallow: and a masonry wing dam 3 ft. high was carried two-thirds across the stream at an angle of 45° with the current. This diverts the flow into a raceway 14 ft. wide discharging into a 7-ft. penstock built of ¼-in. iron. The penstock follows the surface of the ground and has one 45° and two 90° elbows in its course. The pipes which lead off from the penstock to the turbines are each 4½ ft. in diameter and have Ludlow straightway valves operated by gearing.

As the river is subjected to floods, the turbines are placed 16 ft. above its bed, and each turbine discharges through an independent draft tube 10 ft. long, the lower end of which opens in a shallow well. The horizontal shaft through each turbine case carries a grooved pulley on each end, and the power is conveyed by rope transmission to a counter shaft in the second story of the station. The rope used is a 1-in. Manilla "stevedore" rope, laid with plumbago and tallow, and the transmission is on the American plan of using a single rope. The guide pulley which leads the rope from the last groove of one pulley back to the first groove of the other is mounted on a weighted car running on an inclined plane, following in this particular cable railway practice.

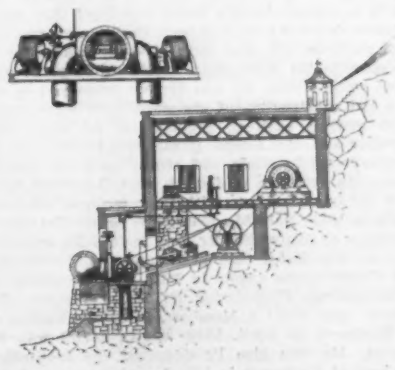
The pulleys on the turbine shafts are 42 ins. diameter. Those on the countershaft are 84 ins. The speed of the rope is 6,594 ft. per minute. The author states that he has found rope transmission more durable than belting, especially for damp locations, provided the speed of the rope is not above 7,500 ft. per minute and the smallest sheaves are at least 40 times the diameter of the rope. Caution should be observed, however, in loading the car which supports the idler pulley.

The arc dynamos have a maximum potential of 2,500 volts, and the incandescent of 1,000 volts. Each of the four arc dynamos has a belt speed of 3,863 ft. per minute, with a consumption of nearly 50 HP. each when under full load. The incandescent dynamo has a belt speed of 5,024 ft. per minute and under full load consumes 750 HP. This dynamo is driven by a 1¼-in. rope leading from the countershaft to a 28-groove, 60-in. pulley on a 9-in. shaft.

The arc dynamos are run in two series, so as to reduce the amount of wiring to two circuits, the line being 16 miles long.

To economize in copper for the incandescent circuit, the potential is increased to 5,000 volts by a bank of 10 step-up transformers, of the "F" oil type, which have an efficiency of 98%. Step-down transformers reduce the potential to 1,000 volts at the central station in Guadalajara.

Lightning being very severe in the locality, iron poles are used, each surmounted by a pointed arrester extending 3 ft. above the top of the pole and about 5 ft. above the highest current wire. The



Water Power Electric Light Plant, Guadalajara, Mexico.

arresters are not only properly joined with the poles, but in addition are connected by a line of iron wire. There are also lightning arresters at both the power and central stations. The entire plant was put in by a private company, of which Mr. J. M. Bermegillo is President.

PERSONALS.

Mr. J. R. Lawrence has been re-elected City Engineer of Greenville, S. C.

Mr. W. R. Busenbark, Traffic Manager of the Chicago Great Western R. R., has resigned.

Mr. H. A. Kennedy has been appointed General Superintendent of the Cleveland, Canton & Southern R. R.

Mr. Aldace F. Walker has resigned his position as Chairman of the Joint Committee of the Central Traffic Association and Trunk Line Association.

Mr. J. T. Odell has resigned his position as General Manager of the Baltimore & Ohio R. R. and has accepted the position of General Manager of the Northern Pacific R. R.

Mr. Arthur F. Wendt, mining engineer, of New York, died in Berlin, Germany, Oct. 5. He was born in 1852, at Milwaukee, Wis., and graduated from the Columbia School of Mines in 1873. He was engaged in the course of his work in the mines of Maryland, Pennsylvania, Tennessee and Arizona. In 1886 he was sent by a company to the Argentine Republic and Chile to reopen the silver mines deserted by the Spaniards in those countries, and was successful in this. Mr. Wendt wrote a number of papers on his experiences in South America, and for his monograph "The Pyrites of the Alleghanies" Columbia College conferred the degree of Ph. D. upon him.

Passed Assistant Engineer Ira N. Hollis, U. S. N., has resigned to take the chair of steam engineering in Harvard University. Mr. Hollis was appointed from Kentucky, as a cadet engineer, Oct. 1, 1874, and has made an excellent professional record as one of the chief assistants of Chief Engineer George W. Melville, Chief of the Bureau of Steam Engineering, U. S. N., and as instructor in Union College from 1881 to 1884. He has contributed freely and well to the literature on steam engineering. His appointment is a very excellent one for the subject matter to be treated at Harvard.

Mr. D. Lowber Smith, Assistant Deputy Comptroller of the city of New York, died Oct. 10, at the age of 45. He graduated from the New York Free Academy (now the College of the City of New York), and became a civil engineer. He was appointed an engineer in the city Department of Public Works, and in 1883 was made Water Purveyor, and in 1884 Deputy Commissioner of Public Works, by Mr. Hubert O. Thompson, then Commissioner of Public Works, which latter position he held until 1884, when Mr. Squire was Commissioner. In 1886 Gen. John Newton was appointed Commissioner, and reinstated Mr. Smith as Deputy Commissioner, and in 1888 Mr. Smith was appointed Commissioner of Public Works by Mayor Hewitt, General Newton having resigned. In 1889, when Mayor Grant appointed Mr. Thomas F. Gilroy as Commissioner for four years, Mr. Smith refused to surrender the office and carried the case to the courts, claiming that his term was until May 1, 1892, but the Supreme Court decided that his term ended on May 1, 1889, and he thereupon gave up the office. He was a director in the Panama Railroad Co.

Mr. Thomas Hawksley, the celebrated English engineer, whose death was noted in our last issue, was born in Nottingham in 1807. In 1830 he was already engaged in a scheme for the water supply of that town, and before his death he had been engineer of over 150 similar projects. He first introduced the constant supply system in his Nottingham works of 61 years ago. Besides water-works, he was largely interested in the design and construction of gas-works, sewerage plants and in general sanitary engineering. In 1857, with Mr. Bidder and Mr. Joseph Bazalgëtte, he was one of the commission to study and report upon the metropolitan main drainage of London, and the works were carried out in accordance with their recommendations. In 1868 he gave valuable testimony before the Royal Commission on Water Supply, and in 1883 he appeared before another Royal Commission, on the Purification of the Thames; and again, in 1892, he gave advice to the Metropolitan Commission on Water Supply. Mr. Hawksley was made a Member of the Institution of Civil Engineers in April, 1840, and in 1871-3 was its President. He was also President of the Institution of Mechanical Engineers in 1876-7, and was one of the founders and the first president of the Gas Institute. He was made a Fellow of the Royal Society in 1878, and was decorated for engineering services by the sovereigns of Austria, Sweden, Denmark and Brazil. He was an unquestioned authority on all matters pertaining to the designs, construction and maintenance of water works, and was a thorough, painstaking engineer in all he undertook. He died on Sept. 23, 1893, having been actively at work up to within one week of his death.

NEW PUBLICATIONS.

THE PHOSPHATE INDUSTRY OF THE UNITED STATES. Sixth Annual Report of Carroll D. Wright, Commissioner of Labor, Washington, D. C. 1893. 8vo; pp. 145; with maps and photogravures.

This report of Commissioner Wright is divided into three sections, as follows: The phosphate industry of Florida, 69 pages; the phosphate industry of South Carolina, 14 pages; and the statistics of the phosphate industry, 62 pages. In introducing his subject Mr. Wright fixes the dates of the introduction of commercial fertilizers as follows: 1833, Thomas Graham, a Scotch chemist, published his investigations into the chemical nature of phosphoric acid and phosphatic salts, and the result was the widespread use of bone-dust as a fertilizer. About 1841, Liebig, the German chemist, discovered that a treatment of bone-dust with sulphuric acid made the contained phosphate of lime more soluble so that one bushel of bone-dust dissolved in one-third its weight of sulphuric acid was superior to four bushels of bone-dust not so treated. Previous to this discovery from 1,000 to 1,200 lbs. of bone-dust per acre was required to secure the best results. In the same year, 1841, guano was first introduced from the Chincha Islands, of Peru, and as it was naturally more soluable than bone-dust the demand for it rapidly increased. The phosphate industry began to be actively developed in South Carolina in 1867, and in Florida in 1888. The development came when the supply of bone and other manures was rapidly decreasing.

The report then treats at length upon the geology, distribution and mining of the phosphates of Florida and South Carolina. Passing these by we come to the statistics of the phosphate industry as being more interesting to the general reader. From the matter given in the report we make the following general statement for the year ending Dec. 31, 1892, the data being given with the understanding that it is subject to some insignificant notes and changes, in some cases, which are given in the original, but not considered here:

	Florida.	S. C.	N. C.
Land mines, No.	88	23	1
River mines, No.	18	7	0
Total mined, tons	532,027	698,976	700
Value at mine	$2,821,849	$4,328,492	$2,800
Quantity shipped, tons*	420,433	612,276	700
Acres controlled	179,343	69,790	2,500
Capital invested, plant	$2,140,582	$2,563,200	$2,000
" " land	$11,346,067	$2,920,000	$100,000
Cost of labor	$881,711	$1,590,689	$1,215
Average number employees.	3,015	5,242	18
Average yearly earnings	$225	$303	$68

The average cost of producing the Florida phosphates, as figured from statistics gathered from 71 land mines, is $2.65 per ton of 2,240 lbs., divided as follows: Labor $1.88; officials and clerks, $0.30; supplies and repairs, $0.42; taxes, $0.05. In North Carolina the cost per ton is $3.18; and in South Carolina it is $3.49¾; all for land mines. The average cost per ton for phosphates obtained from 12 river mines in Florida is $1.95, including 6 cts. per ton royalty to the State, and for four river mines in South Carolina the average cost is $2.35½ per ton, including $1 per ton royalty to the State.

Since 1867, when six tons were sent to domestic markets, to 1892 inclusive, South Carolina has shipped from Beaufort and Charleston 2,474,561 tons to foreign markets; 3,222,246 tons to domestic markets, and 1,189,047 tons were manufactured at home. This is a total production of 6,885,854 tons, with a total domestic consumption of 4,411,293 tons. From 1888 to 1892, inclusive, Florida phosphates were shipped to the extent of 502,617 tons, the shipment for 1888 being only 813 tons. The bulk of the Florida phosphates goes to foreign markets. Mr. Wright says that the most reliable data obtainable show the total consumption of mineral phosphate in the world for 1891 to have been 1,587,133 tons. Of this amount France produced 400,000 tons, or 25.20%, and the United States furnished 757,133 tons, or 47.70%. The mines of phosphates in South Carolina have paid to the State in royalties the sum of $2,805,971 from June, 1870, to 1891, inclusive. The average price, per ton of 2,240 lbs., for South Carolina phosphates for the period 1882 to 1891, has been $12.01¾ in the English market. In 1891 the average price of American phosphates in the home market was $6.92 per ton.

IRRIGATION IN SOUTHERN CALIFORNIA. Issued for the Use of the Delegates to the International Irrigation Congress, Los Angeles, Cal., Oct. 10-15, 1893, by the Publication Committee. Fred. L. Ames, Chairman; C. D. Willard, Secretary. By Harry Ellington Brook. 12mo; pp. 48; illustrated.

This little pamphlet describes some of the notable irrigation works in Southern California and gives general information regarding the counties of that part of the state.

WATER-WORKS REPORTS.—The following water-works reports have been received, the names given being those of superintendents, unless otherwise stated:

Franklin, N. H., W. F. Daniel, Commissioner. Boston, Mass., Robt. Grant, Chairman Water Board. Marlborough, Mass., additional supply, Geo. A. Stacy; B. R. Felton, City Engineer. Albany, N. Y., Geo. I. Bailey. Amsterdam, N. Y., A. H. De Graff. Little Falls, N. Y., S. E. Babcock, Chief Engineer. Troy, N. Y., Edward Dolan, Yonkers, N. Y., J. A. Lockwood, Erie, Pa., Wm. Himrod, Secretary. Reading, Pa., Wm. B. Albright. Richmond, Va., C. E. Rolling. Saginaw, Mich., John Weller. Clinton, Ia., S. M. Highlands. Galveston, Tex., new supply, W. Kiersted, Consulting Engineer; Prof. T. M. Drown, Chemist. St. John, N. B., Gilbert Murdoch.

COMPROMISE STANDARD SYSTEM OF LIVE LOADS FOR RAILWAY BRIDGES AND EQUIVALENTS FOR SAME. By J. A. L. Waddell, M. Am. Soc. C. E.: Kansas City, Mo. Pamph., pp. 8; 4 plates; 25 cts.

This pamphlet presents the compromise system of live loads which the author advocates to be adopted in computing strains in place of the method of wheel concentrations now in vogue. Most of our readers are familiar with the proposed new method, either through the author's circulars or the discussions in this and other journals and before the American Society of Civil Engineers.

UNITED STATES GEOLOGICAL SURVEY: Report for 1889-90. By J. W. Powell, Director. Part I., Geology; 4to, pp. XV., 757; 66 plates. Part II., Irrigation; 4to, pp. IX., 351; 30 plates. Pub. Doc.

The bulk of the volume on geology is taken up with a paper on "The Pleistocene History of Northeastern Iowa," by Mr. W. J. M'Gee, and "The Natural Gas Field of Indiana," by Mr. Arthur John Finney. Both of these papers are handsomely illustrated. Part II., on irrigation, was published in advance of Part I., and was noticed in our issue of Feb. 23, 1893.

THE NEBRASKA CITY BRIDGE: A Report to Charles E. Perkins, President Chicago, Burlington & Quincy R. R. Co. By Geo. S. Morison, Chief Engineer. Paper, 14 × 22 ins.; pp. 25; plates, 20.

This is a historical description of the railway bridge built across the Missouri River at Nebraska City, Neb., in 1888, for the Chicago, Burlington & Quincy R. R. The text has been carefully prepared for engineering readers and is fully illustrated by the plates of details. A fine illustration in photogravure of the completed bridge forms the frontispiece of the report.

DUTY TESTS OF TRIPLE EXPANSION PUMPING ENGINES.—The Edw. P. Allis Co., Milwaukee, Wis. 8vo; pamph.; illustrated.

This pamphlet gives an account of the test of an 18,000,000-gallon pumping engine for the Milwaukee water-works and three 15,000,000-gallon pumping engines for the Chicago water-works. The duty of the Milwaukee engine per million B. T. U. was 137,656,000 ft.-lbs. and per 1,000 lbs. of feed water, 152,448,000 ft.-lbs., the latter duty being reported as the highest on record. The results of the Chicago test were given in our issue of Aug. 24, 1893.

SPECIFICATIONS FOR ROOFS AND IRON BUILDINGS. By C. E. Fowler, Chief Engineer Youngstown Bridge Co., Youngstown, O.

These are, we believe, the first general specifications for iron buildings and roofs to be printed. In general they do not appear to vary materially from the best practice in modern iron building and roof construction, but raise the standard considerably above the light construction used in most of the smaller structures of this class. Those of our readers who desire these specifications in full can probably obtain copies from Mr. Fowler upon request.

SOCIETY PROCEEDINGS.

INTERSTATE IRRIGATION ASSOCIATION.—A convention of delegates from nine states was held at Salina, Kan., on Sept. 28, and organized the above association, for the purpose of promoting the cause of irrigation. Resolutions were adopted declaring it the duty of Congress to make an appropriation to enable the government to determine by experiments whether the underflow of waters is of sufficient volume and whether it could be brought to the surface at a cost to make it available for general irrigation purposes, and whether reservoirs can be constructed for the purpose of storing water in quantity sufficient for irrigation purposes. The following officers were elected: President, E. R. Moses; secretary, J. L. Bristow, Salina, Kan.; treasurer, Frank Hagerman.

BOSTON SOCIETY OF CIVIL ENGINEERS.—A party of 13 of the French engineers who have been visiting this country were entertained by the Society's reception committee during their two days' visit to Boston on Oct. 4 and 5. On the morning of Oct. 4 the visitors were escorted by the reception committee through the Boston parks. They were conveyed by a special electric car from the United States Hotel to Franklin Park. Carriages were in waiting here, and the guests were taken through Franklin Park, the Arnold Arboretum and the private grounds of Prof. Chas. S. Sargent. Then the party proceeded through Brookline to the Chestnut Hill Reservoir. Here Mr. Desmond Fitz-

* In the phosphate industry production is usually measured in tons of 2,240 lbs., and sales or consumption in tons of 2,000 lbs. In the above table all tons are figured at 2,240 lbs.

gerald explained to the visitors the features of principal interest in connection with the Boston waterworks. The return to the city was made by way of the Beacon St. Boulevard, and a brief stop was made at the Institute of Technology. Luncheon was served for the visitors at the Union Club.

The afternoon was spent in a trip down the harbor to inspect the pumping station of the sewerage system and other features of interest, and in the evening theatre parties were made up. On the following day an excursion was taken to Lawrence and Lowell and the party were entertained at luncheon by the Lawrence Boat Club.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting on Oct. 4 a paper by Mr. J. P. Frizell on the "Storage and Pondage of Water" was read in full. An abstract of this paper was given in our last issue. Brief discussions were presented by Messrs. Foster Crowell, Wm. E. Worthen, Jas. Owen and Chas. B. Brush. The nominating committee presented the following nominees for the officers of the society for the next year: President, Wm. P. Craighill; Vice-Presidents, Francis Collingwood and Jos. M. Wilson; Secretary, Chas. W. Hunt; Treasurer, John Bogart; Directors, Wm. H. Burr, Bernard R. Green, Jos. M. Knap, T. Guilford Smith, Robert B. Stanton and Henry D. Whitcomb.

At the regular meeting on Oct. 18 a paper on "Railroad Location," by Michael L. Lynch, M. Am. Soc. C. E., will be presented. The following abstract of this paper is given in the society's "Bulletin":

The paper begins with the statement that fixed or inflexible rules for location cannot be laid down, and the author believes that a discussion of the general principles involved in the best modern practice is the most practical way in which to treat the subject.

He takes up first the reconnaissance for a proposed railway, and assumes a case where it is desirable to connect two cities 250 miles apart with a line of railway, which it is necessary or desirable should pass through several intervening towns. As a preparation for the reconnaissance, which is the first thing in order, the best general map of the country, together with detail, county and township maps, should be procured. Usually the general map will show the existence of two or more possible routes, and afford a knowledge of the drainage of the country with which the engineer must be thoroughly familiar. He can also approximately determine where to expect the steepest gradients, as the divide between two main drainages is never equidistant between the streams; the nearer the divide to one of the streams, of course, the steeper the slope on that side. In this connection the writer says that where a stream flows east or west, the south slope of the valley is generally steeper, rougher and more broken than the north slope, the latter being the smoother slope and with the gentler ascent out of the valley. Where a stream flows north or south, the east slope of the valley is invariably steeper, rougher and more broken than the west slope. In other words, the engineer will find it more difficult to get a line down the valley from the south in the first case, or from the east in the second. This remark applies even on a large scale, as the Pacific slope is much steeper, more abrupt, rugged and broken than the eastern slope of the Continent. The geological reason for this he does not discuss, but mentions the fact as an observation worthy of note by the locating engineer.

In the actual work of the reconnaissance a well-gaited saddle horse will be of great advantage, as much of the work can be done on horseback, and a large scope of the country rapidly examined. In very broken ground or where dense brush or other obstacles interfere, the engineer must dismount and carry a line through on foot. In the use of portable instruments much will depend upon the engineer's skill and familiarity with them, as also upon his judgment of the country. Some men possess the faculty of keeping track of their position and memorizing the country passed through to a very marked degree. The instruments carried are usually the pocket compass, hand level and aneroid barometer. The last mentioned must be used with great care and judgment. Two aneroids accurately rated and compared, and read at the same hours by different observers within reasonable distances apart, will, in settled weather, give reasonably accurate results as to difference of elevation. A leveling instrument is most needed in determining the feasibility of surmounting certain difficulties at governing points, and the writer uses for this purpose a small hand level with sights like a surveyor's compass, and a graduated vertical arc which can be set to any gradient desired, to determine whether the maximum gradient is practicable along a given slope, and the approximate depth of a summit cut.

In reconnaissances, such as that under consideration, several governing points will present themselves, such as the points for crossing certain ridges and important streams, and the touching at certain towns. As a rule, the lowest gap in the ridges should be determined, and the best points for crossing the large streams in the general direction of the line, together with the most suitable entrances and exits from towns; the location of the intervening sections of the line to be made with reference to these governing points. Having made a reconnaissance between the two objective points of the possible routes selected, it is advisable to return by a different route for the purpose of comparison, and in difficult country several routes should be examined, in order to acquire a thorough knowledge of the country. Sometimes a line can be well located along a ridge; at other times such a line would be found impracticable, owing to its narrowness and generally broken and crooked character caused by the minor drainages heading on either side of the general trend of the divide. Copious notes and sketches should be made of each day's work. A thorough reconnaissance such as this, when carefully plotted and sketched in, would be quite a surprise to one not familiar with this class of work, as the lines run with a hand compass, and the distances determined by the time of a well-gaited horse, give quite accurate results. Such a reconnaissance should always be made before starting the instrumental preliminary and location surveys; otherwise the best line in the country may be overlooked.

The next thing in order, after the reconnaissance, is the organization of the party or parties to run the preliminary lines and fix the final location. In thickly settled sections of country the bad practice is sometimes adopted of starting the party out without a camp outfit, providing for their subsistence and accommodation at farmhouses along the line. This is a one-horse arrangement, and cannot be too strongly condemned. A properly equipped party should not have less than three good teams and wagons; tents to accommodate the rank and file of the party, an office tent for the engineers, and one to answer for a cooking and dining tent; a saddle horse for the location engineer, and one for the chief of the party. The party should include draftsman, topographer, cook and teamsters; and the teams, in addition to moving the camp, should carry the lunch to the men at noon, and take them to and from their work. By this means more hours of work can be obtained, and the men will be fresher and in better condition to perform their work.

Of course, the preliminary survey should be run as close to the final location as possible, the chaining should be carefully done, and all angles run with the transit; in other words, the survey should be accurately run as the location is built upon it, and inaccuracies here are sure to cause trouble afterward. This also applies to the work of the topographer, who should sketch accurately the contours, location of streams, buildings, etc., and should use the tape line and slope level, so as to make the map accurate for several hundred feet on each side of the line. For such a survey several preliminary and spur lines may have to be run, and, although the progress may be slow, it is nevertheless good practice to thoroughly develop the country by such preliminary lines before deciding on the final location. Many roads are to-day suffering from the effects of mislocation, caused by forcing the engineer on this portion of his work and not giving the necessary time for proper preliminary examination. The result is an increased cost of maintenance, and an increase in the operating expenses due to moving trains over steeper gradients than are necessary. As a rule, one mile a day of finished located line is a fair average for the time to be occupied for preliminary and location surveys in an ordinary country, partly timbered and partly open; in broken country, less, and in smooth country, more.

The preliminary lines having been completed, tangents and curves of the proposed location should be first projected on the carefully prepared topographical map, before proceeding to locate them in the field. Such location can often be improved, and the best practice is to recognize this possibility and be prepared to make changes in the field when necessary. There is no royal road to railway location, and it cannot be done from a telegraph key or a typewriter desk—it must be executed on the ground by one skilled in this branch of the work. For preliminary maps a scale of 800 ft. to the inch is convenient. In difficult sections 400 ft. is preferable, projecting the location on it, and taking scale and protractor on the line, so as to be prepared to reproject and rerun the line until the best results are obtained. It will also be found useful to have a small strip of profile paper in the field, so that level notes of a doubtful or difficult piece of work can be copied at once. The more experience an engineer has, the more careful he is to take every precaution to get the best line the country affords.

In this day of rapidly increasing speed, it is desirable that reverse curves should not exist. Transition curves may be considered a necessity where the curves are at all sharp. "Broken back" curves, as they are called—that is to say, two curves in the same direction, with a short stretch of tangent between them—should be avoided; a single curve covering the ground and eliminating the tangent can usually be found with a little extra labor. In compensating a gradient for curvature it is generally conceded that 0.04 ft. per station per degree of curve is about right, and at the junction of two gradients on a summit, or the bottom of a depression, it is very necessary to round off the vertical curves. A simple rule adopted by the author is given by an example, thus: Where an ascending grade of 1¼% passes over a summit to a descending grade of 1%, the ordinate of a curve connecting the two can be calculated by taking one-half the sum of the rate of grade per station, regardless of algebraic signs, as the ordinate of correction at the apex, one-fourth of that ordinate as the correction of the first station, one-fourth of this last ordinate as the next correction, and so on. For example, the ordinate at the apex would be $\frac{1.25+1}{2} = 1.12$; one-fourth of this, or 0.28, would be the ordinate for the second station on each side of the line of the apex; one-fourth of this last, or 0.07, at the third station, and so on. These calculations for vertical curves can be performed mentally, and the resulting curves give good practical results. The absence of vertical curves at the foot of all steep gradients is a fruitful source of derailment. It is quite apparent that methods such as have been described are inapplicable to countries where topographical surveys already exist, upon which the location can be intelligently projected and the line approximately laid out in the office. This system applies more for countries like America, Russia and others of large extent, where large areas are yet uncovered by topographical surveys.

By order of the Publication Committee no advance copies of papers presented during the remainder of this year will be issued. Instead of this, very full abstracts of papers will be published in the "Bulletin," giving all that is of importance in them; of course, omitting tables and plates. It is intended that such publication shall be sufficiently in advance of the meetings to allow the presentation of written discussions. Discussions can also be sent in after a paper has been presented.

COMING TECHNICAL MEETINGS.

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 10-14. Los Angeles, Cal. Arthur L. Thomas, Salt Lake City, Utah, Chairman National Executive Committee.
WESTERN RAILWAY CLUB.
Oct. 17. Secy., Clement F. Street, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
Oct. 17. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Oct. 17. Secy., R. H. Clark, Pittsburg.
INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17-19. Annual Convention at Continental Hotel, Philadelphia. Secy., S. F. Patterson, Concord, N. H.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 18. Secy., S. E. Tinkham, 36 Broomfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 18. Secy., L. V. Carmait, Roanoke, Va.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct 18-20. Annual Convention at Milwaukee. Secy., Wm. J. Richardson, Brooklyn, N. Y.
ENGINEERS' CLUB OF ST. LOUIS.
Oct. 18. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 18. Secy., F. Collingwood, 127 East 23d St., New York.
NEW YORK RAILROAD CLUB.
Oct. 19. Secy., John A. Hill, Temple Court, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Oct. 19. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Oct. 19. Secy., Allen Strale, 100 Washington St.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Oct. 20. 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 21. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
Oct. 21. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
DENVER SOCIETY OF CIVIL ENGINEERS.
Oct. 23. Secy., F. E. King, Jacobson Block.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Oct. 26. Secy., C. H. McLeod, Montreal, P. Q.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Nov. 6. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Nov. 7. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Nov. 8. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
Nov. 9. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERING ASSOCIATION OF THE SOUTH.
Nov. 9. Secy., W. G. Kirkpatrick, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Nov. 9. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Nov. 10. Secy., D. W. Meeker, St. Paul.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Nov. 10. Secy., F. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 10. Secy., O. Von Geldern, 719 Market St., San Francisco.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Nov. 11. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
Nov. 13. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Nov. 13. Secy., M. F. Schinke, City Hall.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Nov. 14. Secy., F. C. Osborn, Case Library Bldg.
NORTHWEST RAILROAD CLUB.
Nov. 14. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Nov. 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Nov. 15. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Nov 15. Secy, F. M. Curtis, O. C. R. R., Boston.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov 16. Secy, S. A. Charpiot, Macon, Ga.
CENTRAL RAILWAY CLUB.
Nov. 22. Secy., S. W. Speer, Buffalo, N. Y.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon: new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering headquarters, at Chicago, are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains, and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

The use of triple-expansion in high duty pumping engines seems to be on the increase. We give this week in our "Contract Prices" column a comparison of the bids for a 15,000,000-gallon high duty pumping engine for the Providence Water-Works. The City Engineer, Mr. J. Herbert Shedd, compared the annual cost to the city of the several engines on the basis of 4% per annum on the cost of the engine, and a cost of fuel of $5 per ton. The duties which the bidders were willing to guarantee for compound engines were from 105,000,000 to 115,000,000, while two bidders offered guaranties of 125,000,000 for a triple-expansion engine. The engine selected, however, is a Worthington triple-expansion with only 120,000,000 duty guaranteed. The same firm offered to guarantee 125,000,000 for a triple-expansion engine which should be a duplicate of the one selected in every particular save that it would be built to work at 155 lbs. steam pressure instead of 125. The comparison showed that this engine, notwithstanding an increased first cost of $9,000, would save about $300 a year by reason of its higher duty; but it was not considered that this was a sufficient gain to warrant the use of the higher pressure. Another fact of interest in connection with these bids is the very low price at which this class of steam machinery can now be purchased. The lowest bid for this plant was only about $55,000, and this for an engine for which 115,000,000 duty was guaranteed.

The dangers of running trains in sections where some system of blocking is not in force has so impressed the managers of the Michigan Central that during the recent rush of traffic to Chicago they have adopted the plan of running double-header passenger trains in preference to dividing the trains into sections. Some of these trains have had as many as 22 cars, carrying an average of 65 passengers per car. It is a question whether the gain in safety from rear collisions made by this plan is as great as the increased danger in case of derailments or head collisions with such long trains. That a derailment is more likely to have serious consequences with a long train than a short train, both theory and experience go to prove. A car off the track at the head of a three or four-car train may plow through the dirt a rod or so and stop the train unharmed. With a very long train there is far more inertia to absorb, and the car may push along until it meets some obstruction and then be telescoped; or, it may be forced down the bank by a long train, when with a short one it would have been stopped before it had gone far from the rails. Similarly when a very long train meets another in a head collision or runs at full speed onto a switch set for the side track, the cars which take the brunt of the shock are much more likely to be telescoped than if only a few cars were pushing on from the rear.

The practice of running trains in sections with no protection but an elusive time interval and an uncertain brakeman, is so dangerous that only the force of habit permits its continued use. It is by no means certain, however, that much if any gain is made by doubling up the trains, especially if high speed is to be attempted. If there is no way to distribute the traffic among the regular trains, the better plan would seem to be to have the train dispatchers keep the extra train, run as a section of a regular train, at least one station behind the regular. We believe the Michigan Central already does this to protect its trains in case of fog, and we fail to see why it may not be easily applied to the protection of its trains run in sections.

As we have often pointed out, American railway practice as a whole is seriously backward in the use of block signals; and the remarkable series of bad train accidents which have been occurring all summer will not have been in vain if it serves to emphasize that fact and to hasten the inevitable day when practically all our lines will be run by it or by its equivalent for lines of thin traffic, the train staff system. A small but increasing number of our leading lines have first-class block systems in use, and many more have station block and other less perfect systems; but it is rather the rule than the exception that the pernicious "permissive block" system is used to such extent as to encroach most seriously on the actual degree of safety obtained in the times when it is most important, when the traffic is crowded and disarranged; and on our lines of lighter traffic the block system in any form has as yet hardly gained a foothold. There is a reason for this backwardness which is not altogether to our discredit. We early invented and put into use the train dispatcher system, which was a great improvement on the earlier method of running by schedule only; whereas the European railways went at one jump from the schedule system to the block system, few if any of them having ever had any form of the American train dispatching system in use.

But the invention and perfection of train-staff system long since did away with any real excuse for neglecting some form of absolute block, even on light traffic lines; and it goes without saying that such important railways as the main lines entering Chicago ought not to be without some more perfect form of block signals, and will not be much longer. Their traffic has grown beyond all possibility of handling it in times of pressure without too frequent accidents, as this summer's long drawn out series of accidents has proved. Man is a fallible creature; and any chain in which his continuous fidelity and attention is a necessary link is sure to break often. Machinery only can be made always cautious, and that lesson has been brought home this summer with great force.

The fifth statistical report of the Interstate Commerce Commission for the year which ended June 30, 1892, has reached the stage at which an advance abstract has been given out for publication. The figures are given in another column. They tell for the most part an old story, which has been already brought to public notice by other statistical publications. As respects accidents, however, this official report is our only reliance for complete figures; and we regret to say that the figures do no credit to the railways of the United States as a whole. In the year covered by the report 376 passengers were killed, or 83 more than in the preceding year; and 3,227 passengers were injured, which was an increase of 255. There was a slight decrease in the number of employees killed, the total being 2,554, or 106 less than last year. The number injured, however, was increased, being 28,267, an increase of 2,127 over the preceding year.

These increases are not accounted for by the increases of traffic; the percentage of deaths and injuries of both employees and passengers show a steady increase in proportion to the number employed and the number of travelers over the previous year; and that also showed an increase over the year ending June 30, 1890.

The report states that in the year ending June 30, 1892, one passenger was killed in every 1,491,910 passengers carried. In England, during 1891, the proportion was one passenger killed in each 8,208,335 passengers carried. Thus, it appears that the risk in railway travel is nearly six times as great in this country as in England. Actually, however, the disproportion is far greater than this. In England only five passengers all told were killed in train accidents during 1891. In this country the report before us shows that 177 passengers were killed in collisions and derailments alone during the year. No better proof could be furnished that the railways of the country have outgrown the makeshift methods of operation which date back to the days of cheap roads and thin traffic; and they cannot proceed too rapidly in changing their methods and appliances to suit modern traffic conditions.

An important discovery in engineering has been made by the Common Council of New Brunswick, N. J., and we hasten to give our readers the benefit of it, quoting it in full as reported in the daily papers:

> The Common Council of New Brunswick having arrived at the opinion that it was costing too much to lay sewers by contract, last month appointed a special committee to act with the Street Commissioner and City Surveyor in laying 25 ft. of sewer, as an experiment, the city hiring the labor and purchasing the material. The committee has finished its work and last night made a report to Council, showing that the experiment is a complete success.
>
> The cost of laying the sewer was said to be only $1.50 a lineal foot, while the lowest bid offered for the work when advertised was $2.65 per lineal foot. The report was so satisfactory that the Council at once ordered that the entire work of the sewerage construction be completed in the same manner.
>
> The city will save many thousand dollars by the move, and it is believed that the sewers will be constructed better than under the contract method.

Contractors who have been rapidly amassing wealth by taking sewer contracts on which 76% profit can be figured had better retire on the fortunes they have already accumulated. The New Brunswick fathers have discovered that by simply laying 25 ft. of sewer, at a total cost of only $37.50, they can find just what profit their contractor is going to make. No longer can the contractor pose as a man who works hard for big risks and small profits. The New Brunswickers have exposed his pretenses. Engineers also will be vitally interested in this important discovery. There will be no need henceforth for their expensive services in making estimates. Practical trial on the ground beats their tables and theories; and they had better take time by the forelock and apply for jobs as day laborers on the work.

There is one feature, however, of the New Brunswick plan which must be severely condemned. The members of the Common Council recklessly and extravagantly ordered the construction of 25 lin. ft. of sewer for experimental purposes, when 10 ft. would have done exactly as well. It is true that this 25 ft. has been laid, and at a cost which cannot be claimed to be exorbitant; but the committee did not know this would be the case when

they authorized the construction of such a long stretch of work. We urgently advise those who propose to adopt the New Brunswick discovery to beware how they risk too large sums of the funds in their care on such experiments. A man who is good at figures can calculate the cost of a sewerage system when the cost of 10 ft. is determined just as well as from the cost of 25 ft. With this caution as to its application, we commend the New Brunswick idea to the respectful consideration of our readers.

THE SOARING POWER OF BIRDS.

That the problem of aerial flight is occupying an unusual share of the world's attention is proved not only by the late "Conference on Aerial Navigation," at Chicago, which we noticed and commented on at the time, but by the appearance of a new technical monthly, "Aeronautics," especially devoted to this subject. This new monthly is edited by a well known engineer and writer, Mr. M. N. Forney, whose undertaking of this project shows not only that there is a larger number of persons interested in the subject than might have been supposed, but also that the subject is deemed by so good a judge and so competent and level-headed a man as one likely to assume an increasing importance. That we hold the same opinion has been shown in several articles in these columns.

Nevertheless, this subject is not likely to assume mechanical or commercial importance for a long time to come. Undreamed of revolutions are always possible, but unless helped by some unexpected revolution in the mechanic arts no living person is ever likely to make a penny out of his studies of aeronautics (unless by building balloons or the like), and few who are interested in the subject probably expect or hope to do so. The interest which it excites is precisely that which the game of chess or any good puzzle excites. Here is something which in the present state of the arts is clearly within man's power to accomplish (or certainly is not clearly beyond them) which yet has not been accomplished. It is also a feat which appeals not only to the lower motives which inspire other efforts, but to two of man's noblest traits, his love of knowledge for its own sake and his indomitable energy which will not permit him to say "I can't" until he sees he must.

It necessarily follows that any one starting a paper devoted to such a subject cannot expect much if any pecuniary profit from so doing. It must be largely a labor of love. As such it is especially deserving of support by all those who feel an interest in its subject, and we trust it will receive it. The subscription price is extremely moderate ($1 per year, $1.20 to foreign subscribers), and every one with enough mental energy to spare to keep the run of what is doing in this direction, even if he does not study it himself, should send his dollar to the editor, No. 47 Cedar St., New York.

Among the other subjects for discussion propounded in the program for the late congress, or conference, at Chicago, was this:

> 2. Theories regarding the soaring and sailing of birds. It is now generally admitted that birds utilize the wind in soaring, but no satisfactory explanation of the performance has been given.

Mr. A. M. Wellington, of this journal, undertook to give a satisfactory and complete explanation of the performance, or rather, of just how and why it was possible, in a paper before the conference which we reprint in another column. We leave the paper to speak for itself in respect to the soundness of the argument. Its author thinks still, as he thought some months ago when preparing it, that not only is its explanation demonstrably true in respect to the way in which birds fly through the air with and without taking aid and power from the wind, but that strict compliance with that theory and with the practice of birds opens the only possible road to a real success with a flying machine. He predicts with confidence the complete and utter failure of any and every attempt at flight which relies upon the horizontal thrust of a screw for propulsion through the air, on the ground that this procedure is not only contrary to nature, but contrary to reason as well. So far, nearly all the more serious attempts to solve the problem have been made with horizontal screws; so far every one of them have been complete and utter failures; for it is not success to make a machine which will fly a few hundred feet through the air and then come to the ground. Any boy can make a stone do that.

But while we do not propose to repeat or rehearse here any of the main arguments of the paper, it will do no harm to rehearse a few fundamental facts, which many of those who have studied this problem have unaccountably overlooked.

1. There is not the slightest necessity for assuming that the bird's wings exert any horizontal thrust whatever to explain the phenomenon of horizontal flight. The bird once in air, it has only to extend its wings to slide downhill on them as a boy slides on a sled downhill, only at a much smaller and extremely small angle with the horizontal. Similarly, the bird once gifted with the power of obtaining from its wings in any manner a strictly vertical lifting moment which for the instant or permanently is in excess of gravity, there is no reason why it should not, and every reason why it should, slide uphill (so to speak) propelled by negative gravity, precisely as it may slide downhill propelled by positive gravity, and in each case in a nearly horizontal course. And finally, when the bird is by flapping of its wings alternately endowing its body with positive and negative gravity, there is no reason why it should not be alternately sliding first uphill, downhill and then in this way, in each case at an extremely small angle with the horizontal; so small that to the senses and in practical effect the flight is horizontal throughout. There is, therefore, no necessity to assume that the bird has any power to exert any sort of horizontal thrust to explain all the phenomena of flight. The fish demonstrably needs some sort of propeller to move at all because its body is of the same specific gravity as the fluid it floats in; the bird does not, for the contrary reason. The fish in nature always has it; the bird in nature never has it. For—

2. There is not a particle of evidence to show that the wings ever do exert or can exert any horizontal thrust in normal flight. Impelled by the supposed necessity of assuming such power as the only possible explanation of the bird's horizontal motion various fine-spun theories as to a "figure 8" motion of the wings have been advanced, and sundry persons have supposed that they observed a certain marvelous power of the detached wing of a dead albatross to "draw into the wind," and the like. So can any yacht "draw into the wind" in a certain sense, and any large flat surface may be so held as to do the same in the same sense in some degree. But otherwise these theories and these observations are—we will not say absurd upon their face, but unsupported by a particle of certain evidence or by any explanatory theories which the mind can grasp, and only to be accepted even tentatively in default of any other more reasonable and sufficient explanation. But we have just seen that there is such a one of a simple nature which any one can understand the rationale of.

3. It is probable (and in our judgment certain) that the lifting power of any sort of plane is enormously greater when it has at the same time a rapid horizontal motion so as to rest at each successive instant on a new mass of heretofore undisturbed air. When the bird is rising from the ground, and hence has a very slow horizontal motion, it flies only with extreme difficulty and excessively rapid beating of the wings. After it is once well under way its lazy flapping in otherwise still air gives evidence of a great excess of lifting power, almost as if wings were beating upon a solid substance and lifted the body by as much as their center of area was depressed.

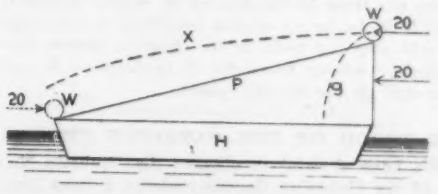
It follows (if this be admitted) that to get any true measure of the lifting power of a screw in air after a flying machine was once under way, we should place the screw on the end of a long horizontal arm revolvable at varying speed through the air at the same time that the screw was exerting its vertical energy. We are not aware that this experiment has ever been tried, and we are of opinion that it would develop an astonishing increase in lifting power. The apparatus would be somewhat complicated and difficult of construction, and, perhaps, the same end might be better accomplished by hanging the whole apparatus as a pendulum from some high building. The resulting variable velocity would afford the basis for very accurate generalizations from graphical records of the lifting power at each instant.

We are tempted to go on with some other points in relation to the general problem apart from the particular one discussed in the paper published elsewhere, but we must do so later if at all. After all, the most important single element of the problem to determine definitely is: (1) Whether or not birds do make the wind work for them by keeping them in the air for indefinite periods and to move them in any desired horizontal or vertical direction without any muscular exertion of their own; and if so (2) how they do it, and whether man may hope ever to imitate them. The first branch of this problem is one no longer. Vultures, eagles, carrion crows, albatrosses and many other birds admittedly possess this power and great flocks of them exercise it for hours together. The second part of the problem is also answered affirmatively in the paper published elsewhere; and if this could be generally admitted, it should prove quite a step toward some real success in aeronautics, because in that case the great problem of how to get power enough to drive a flying machine without excessive weight is reduced to the much simpler one of how to get it once fairly in the air; because once there, the upper air is practically never still and the power for further merely horizontal flight may be taken from the air as the bird takes it, by the maneuvers explained—or sought to be explained.

A valued correspondent, however, who has read the paper in the proof, and who has given such careful study to the whole question as to entitle his doubts to great respect, sends us the following criticism of the theory, the soundness of which we cannot perceive and which we will endeavor to answer clearly:

> What I fail to understand is how the weight W (Fig. 1 in the accompanying paper, and also the cut below) can gather any impulse from the plane P, so that the latter "will keep pushing it ahead."
>
> At the beginning of the fall of W, the speeds are the same (20 miles per hour), and as W gathers increased speed it outstrips the plane, so that the latter can exert no acceleration, and therefore the final velocity of the weight can only be that due to gravity, say 28 miles per hour. If you will test the matter experimentally, say on a railroad train moving 20 miles an hour, I think you will find it as I have stated.
>
> If, however, you will completely reverse the assumed conditions, and consider the weight as at the bottom of the plane, both going at 20 miles an hour in CONTRARY DIRECTIONS, then I can see that additional energy and elevation will be imparted to the weight; and experiment will confirm this; a mere scoop with an inclined plane against a weight at rest, sending it up on the plane.
>
> You will find this action used as an illustration in an article on "Soaring Flight," by Mousillard, soon to be published by the "Cosmopolitan Magazine."
>
> Unless I have failed to understand your reasoning, I think your article should be rewritten, and the argument reversed.

We will endeavor to explain this matter, as the article should not be rewritten nor the argument reversed. Whether sound or not, it expressed the author's argument. A soaring bird may be, of course, at any given instant moving in almost any direction at any velocity. We will take the bird



(the dotted mass W) moving at 20 miles per hour in the position shown against the inclined plane P (the air through which it is about to rise), also moving at 20 miles per hour.

Our correspondent says that in this position he can "see that additional energy and elevation will be imparted to the weight," but this statement is a little beyond what he meant. He can see how it can gain elevation, and any one can; but he cannot see how it can gain energy also, because it cannot do so. That would be contrary to the law of the conservation of energy. It can gain elevation by surrendering velocity or velocity by surrendering elevation, but it cannot do both at once without the intervention of some third force.

In this particular case there will, of course, be the scoop-like action referred to. In more scientific language, the dotted mass W will begin to rise, impelled to do so by the energy represented by the opposing velocities, and it will continue doing so until the two masses come to rest relatively to

each other; in other words, until it is lifted up high somewhere and the two masses are moving in the same direction at the same velocity, i. e., until they are in the relative position shown by the solid mass W at the top of the plane. That part of the problem is very simple; it was assumed to need no explanation in the accompanying paper.

But the difficult question is: What is to become of W now? It cannot rise any further, because it has no more relative velocity to surrender. It cannot keep where it is, because (considering it a bird) it is no longer moving through the air and its soaring (not beating) wings have no sustaining power. It, therefore, must fall, and if it is to keep on in soaring flight, and not fall completely to the ground, it MUST store lifting energy in its body by the process of falling, so as to stop falling before reaching the ground, and without having to begin beating its wings.

It is at this point, therefore, the only crucial point, that the paper assumes the two bodies and assumes to show, not only that it is possible thus to gain energy in descent, but that it is the only possible way in which the bird can take energy from the wind at all continuously.

With this explanation the difficulty propounded in the first sentence above will probably vanish. It is true that when the mass W finally completes its fall in the path x it is moving through space faster than the wind; under the conditions assumed just twice as fast finally; but this is only because its path is then oblique. At no time and at no point is its horizontal motion any greater than 20 miles per hour. It cannot be, and does not need to be, for the resulting final energy does not at all depend on the direction of motion, but only on the velocity through space in whatsoever direction.

What the wind does is to compel the body to fall in the long path x rather than the short path g. To do this it must, of course, be imparting energy to the body (bird) continuously. Having this energy once stored in its body, the bird turns and faces the wind (i. e., puts itself in the position of the dotted W), and is, of course, scooped up higher into the air, as explained. The problem is not to explain the lift, but to explain where the energy comes from that causes the lift.

It is experimentally certain that a body rolling down an inclined plane on a railway train will take energy from it in the same way. If the train be moving at 20 miles per hour and the body rolls down the plane through a height of 13.38 ft., it will be moving at its foot at a velocity of 20 miles per hour relatively to the train and $20+20=40$ miles per hour relatively to the earth. It will, therefore, either roll up an opposing plane 13.38 ft. high if carried on the train, OR (what is the true measure of its total energy) up an opposing stationary plane $13.38\times4=53.52$ ft. high. The gain of $53.52-13.38=40.14$ ft. is energy taken from the train in the process of rolling downhill: and if W be heavy enough relatively to the train it will stop the train in its effort to absorb this necessary energy to enable it to continue to roll downhill on the moving plane.

AN ERROR OF THE CANADIAN CENSUS.

We have chanced to observe that Bulletin No. 11 of the Canadian Census contains a most surprising error on page 4, resulting in a great exaggeration of the apparent growth of population in the "four original provinces of the Confederation," viz., Ontario, Quebec, New Brunswick and Nova Scotia, without any counterbalancing error in any other part of the country, a clean addition of 100,000 being made to the true figures, and not merely a transfer. The increase in population of the four specified provinces is stated as 430,455, whereas it was really only 330,455, against 139,014 in the other four provinces (Prince Edward's Island, Manitoba, British Columbia and Northwest Territories). The error is the more singular because the group for which this large error is committed is the only one for which any comparative statement or deduction of percentages is given, the percentages being, of course, very far astray, and quite too favorable.

In a bulletin of this kind relating to the "Birthplaces of the people" of the entire Dominion, one would naturally expect to find the figures for the whole Dominion summarized in great detail, and if a detail percentage summary were given for one group of four provinces, it would be natural to make it also for the remaining group of four, especially as this latter group shows, when the figures are correctly given, by far the larger increase, and the results of the Canadian census have not been specially encouraging. Nothing of this kind occurs, however, and thus a chance of checking or detecting the error was lost. The extent of the error may be seen in the following figures, the first two columns being as the bulletin gives it, and the last column (in parentheses) as the second column should have been given:

	1871-81	1881-91	
Increase (total) was.....	+ 558 299	+ 430,455	(+ 330,455)
Increase of native born.....	+ 577,757	+ 461,973	(+ 361,973)
Decrease of foreign born...	— 19,458	— 31,518	(— 31,518)

The true figures show, first, that there is a sharp decrease from 1871-81 in the proportion of native-born remaining at home, about twice as great as the census figures indicate (viz., over 200,000 instead of 100,000); and secondly, that foreign-born residents find even less encouragement to remain in these four older provinces than native-born, there having been a steady and increasing decrease in the absolute number of foreign-born residents in the last 20 years. The Dominion as a whole, however, shows a slight increase in foreign-born residents during the last decade, amounting to 37,173, the increase in natives of England being 49,469, so that all other countries than England show a decrease.

In connection with the correction of this error it will be of interest to give the comparative ratio of increase among native-born Canadians living in Canada and living in the United States, as follows:

Year.	Native born in Canada.	Canadians in U. S.	Ratio U. S. to Can.
1880-81.....	3,685,545	717,157	19.4%
1890-91.....	4,155,014	980,941	23.6%
Increase	469,469	263,784	56.2%
Increase per cent....	12.7%	36.8%	

It will be seen that at the present time about one-fifth of all living native-born Canadians are living in the United States, and that the ratio of Canadian-born increase was about three times as great in the United States as in Canada during the past increase, notwithstanding the fact that all children born in Canada during the past decade go to swell the Canadian increase, while all children born to Canadians living in the United States are classed in the census as native-born. This indicates an exodus of able-bodied adults far in excess of the usually assumed proportion.

These revelations of the census go far to explain the existing status of political unrest in that colony, by revealing to what a surprising extent its population is addicted to emigrating to the United States. The tendency of the error first noted in this article is to diminish this uneasiness, but how an error great enough to attract the attention of a casual examiner in this office could first have been committed and then escape the attention of the census experts of the Canadian office, is certainly a mystery, albeit the showing resulting from the error may have been a welcome one. It is to be remembered that the entire population dealt with is small; only some 4,000,000 for the four provinces. The error was as great in proportion as if our census had accidentally added 1,500,000 or thereabouts to the actual figures of the census, and failed to discover its error by any of the usual checks on such official statistics.

Another fact of some interest in this connection is revealed by our own census, viz., that the proportion of French Canadians among Canadian emigrants to this country is much less than is commonly supposed. These statistics were taken for the first time in our late census, and have as yet been made up only for the six New England states. But it is well known that French Canadians emigrate almost exclusively to New England, and yet the census shows that there are in New England 174,406 English-speaking Canadians of whom we hear nothing, against only 205,761 French-speaking. The contrast probably arises from the fact that the French Canadians emigrate by families and herd together, whereas the English-speaking emigrants are chiefly adults, which are absorbed at once into the general population here, while they leave the families from which they sprung still in Canada.

LETTERS TO THE EDITOR.

CONCRETE BRIDGE PIERS.

Sir: Allow me to contribute a few lines, which may perhaps be of interest, upon the subject of concrete bridge piers, since you have of late given considerable attention to articles describing the construction of various structures, by prominent civil engineers, where concrete was used instead of stone.

During the summer of 1881 I had charge of the construction and engineering work of the piers of a railway bridge spanning the Medina River, 18½ miles west of San Antonio, Tex., on the main line of the Southern Pacific Ry. (at that time the Galveston, Harrisburg & San Antonio Ry.). The bridge consists of two 150-ft. and three 75-ft. iron through spans, and about 900 ft. of trestle approaches. The piers supporting these spans were all constructed of cement concrete, i. e., 1½ parts Portland cement to 2½ parts sand and 4 parts flat flint pebbles about 1 in. square and of uneven surface.

The dimensions of the highest pier are 42 ft. from top of flooring of foundation to top of coping. The concrete foundation rested immediately upon oak flooring and was 12 ft. high, 12½ ft. in width and 37½ ft. long. The battered part was 27 ft. 3 ins. high, top measurement 6 × 22 ft. from shoulder, and 6 × 28 ft. along center line from nosing to nosing. At nosing the batter was 1 in. per ft., at shoulder ¾ in. per ft., and at sides ½ in. per ft. The top of pier was finished by an inverted course 18 ins. thick and coping 15 ins. thick, and projecting over inverted course 8 ins.

The floor supporting the concrete foundation was laid in two courses diagonally upon piles, each course being 12 × 16-in. live oak timber securely drift-bolted to oak piles. The bottom of battered part of pier, commencing at top of concrete foundation, was even with the surface of the dry river bed.

Oak piles were driven to a depth of from 16 to 18 ft., and 3 ft. c. to c., into bottom of excavated foundation pit, and cut off even 15 ft. below surface of ground, or bottom of battered part of pier. The soil in the pit was composed of black alluvial clay mixed with sand extending down 6 ft.; underlying this stratum gravel slightly mixed with sand was found, reaching to a depth of 30 ft. or more.

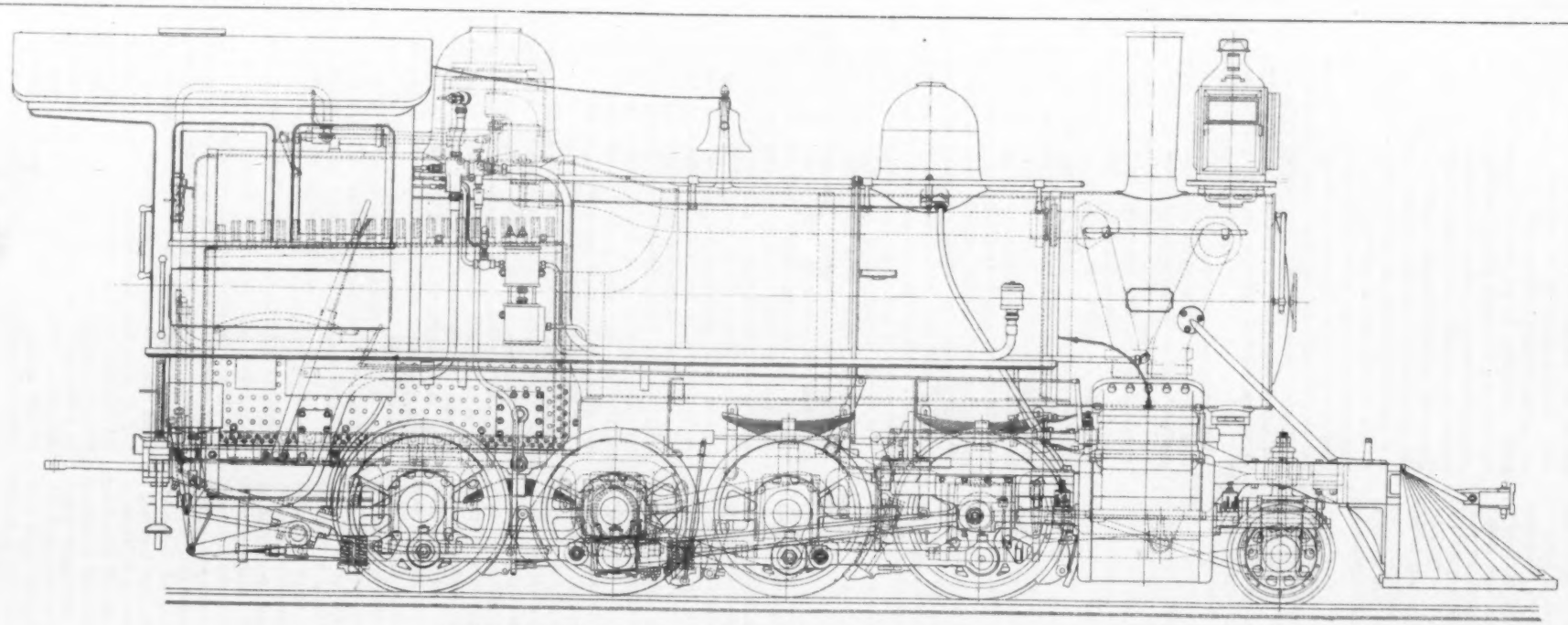
The concrete was mixed near the piers and by means of wheelbarrows emptied into the pier mold, the latter having previously been placed in proper position on concrete foundation bed. The pier mold consisted of a strong frame of 2-in. oak planking, with sides and nosing conforming exactly to the required batter to a height of 15 ft. The concrete, having been thoroughly mixed, was deposited into the pier mold to a depth of 6 ins. and evenly distributed over its entire bottom and subjected to tamping until the concrete became thoroughly hard and compact; a certain quantity of water was then poured over the entire surface, and after this was absorbed the process was repeated for every 6-in. layer until the concrete filling had reached the top of the mold.

The mold remaining in position over night was then removed by means of keys, bolts and iron rods at shoulder and nosing and raised so that the lower edge reached 2 ft. below the point to which the pier had been finished when the mold was in the first position, when, having readjusted the batter to a height of 28 ft., the filling in of concrete was resumed as before. The time consumed for the raising and adjusting of pier mold did not exceed 15 minutes in any case.

The original design for this pier mold was made by Mr. James Burns, of San Antonio, Tex., who was the contractor for the concrete piers. Too much cannot be said here in praise of this device, as it fulfilled more than all practical requirements in the construction of the work. Mr. Burns was able to finish from 4 to 7 ft. in height of the concrete piers per day by means of these molds.

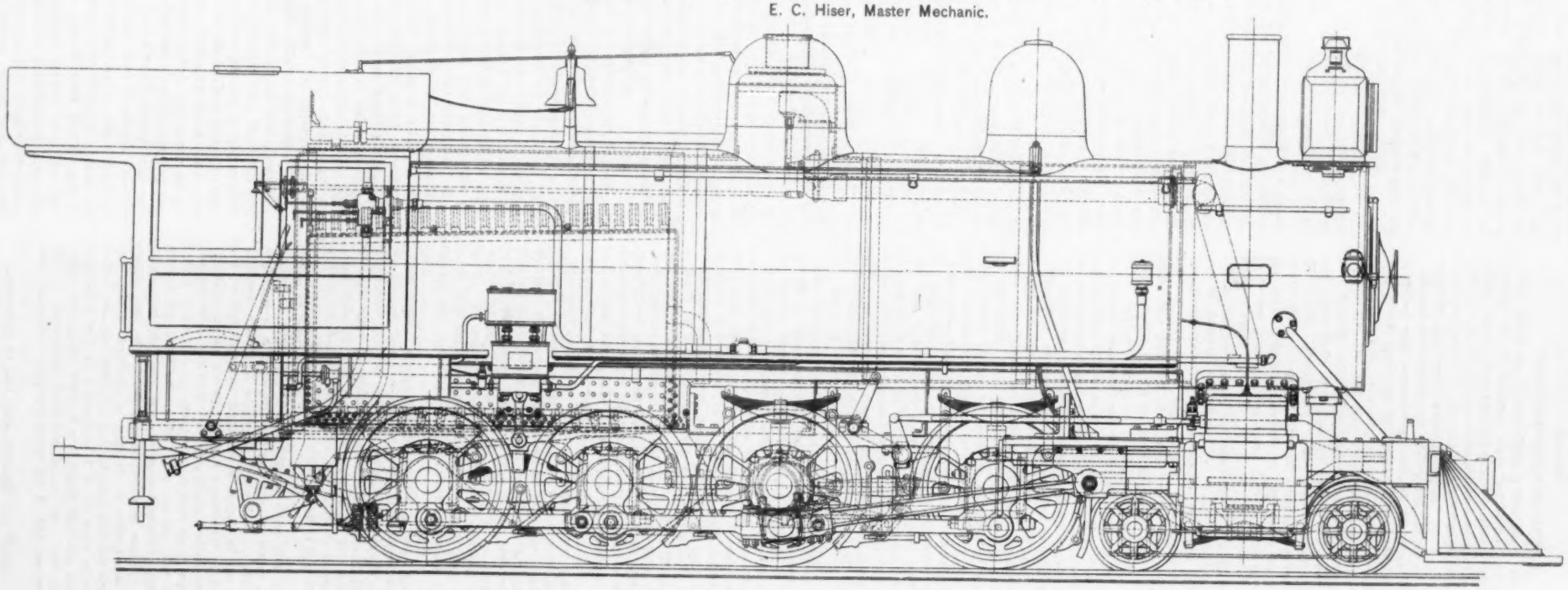
A week after the completion of each pier it was subjected to a thorough examination by Major James Converse, the Chief Engineer of the railway company, and by the assistant engineer in charge of the work. The lines of the nosings showed a perfectly continuous straight line, strictly in accordance with required batter, and the same clear and perfect lines were exhibited at shoulders, sides and coping. The entire surface of the pier on all sides, including inverted course and coping, appeared perfectly smooth, hard and evenly finished. A number of test holes were drilled into the battered part of pier and the concrete foundation bed to a depth of 6 ft. or more at coping, nosing and sides, when it was found that the material had so thoroughly hardened as to be even harder than limestone, weighing from 160 to 166 lbs. per cu. ft.

I have only to add that although the Medina River is subject to sudden floods, occurring every year, raising the water to the top of its banks with swift current, which also means a depth of 20 ft. in the main channel, the bridge piers have withstood them all suc-



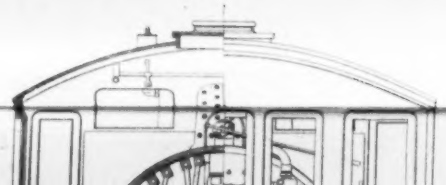
CONSOLIDATION COMPOUND LOCOMOTIVE FOR THE MOHAWK & MALONE RAILROAD.

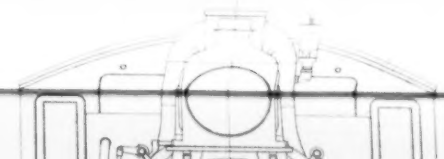
E. C. Hiser, Master Mechanic.

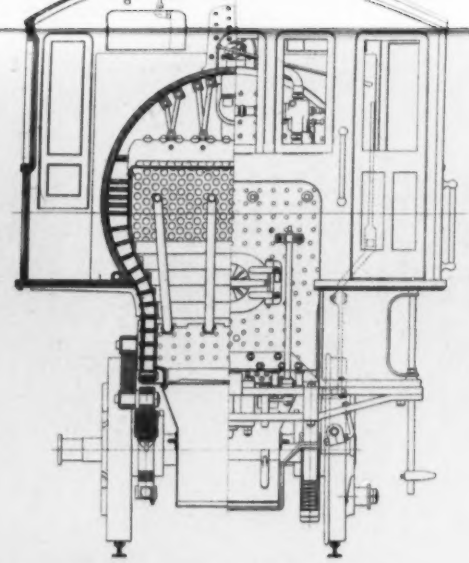


TWELVE-WHEEL LOCOMOTIVE FOR THE DULUTH & IRON RANGE RAILROAD,

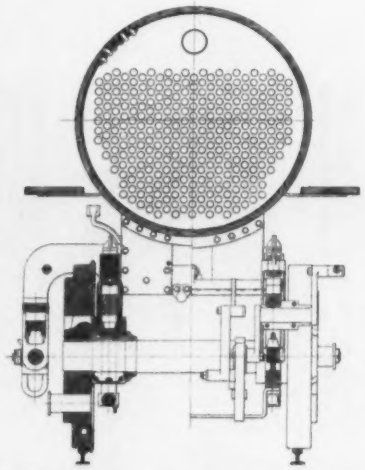
H. S. Bryan, Master Mechanic.



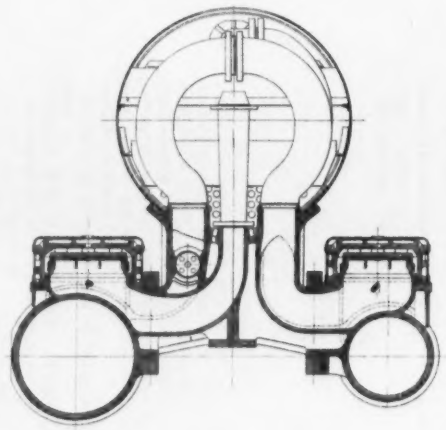




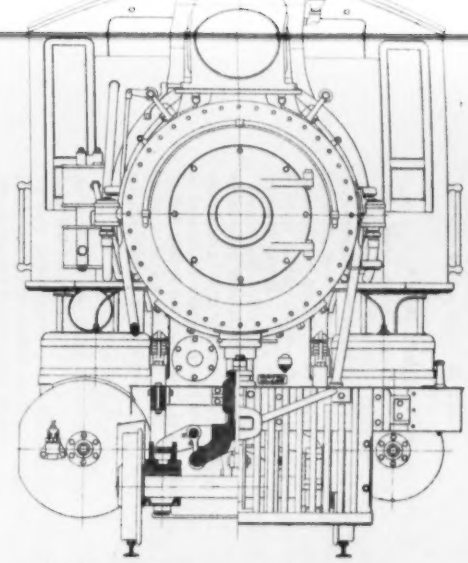
Half Section Through Firebox. Half Rear Elevation.



Half Section Through Front Drivers. Half Section Back of Front Driver.

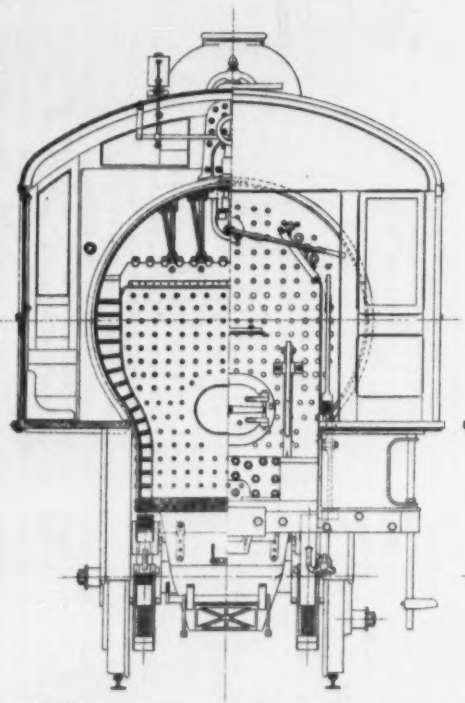


Section Through Cylinders.

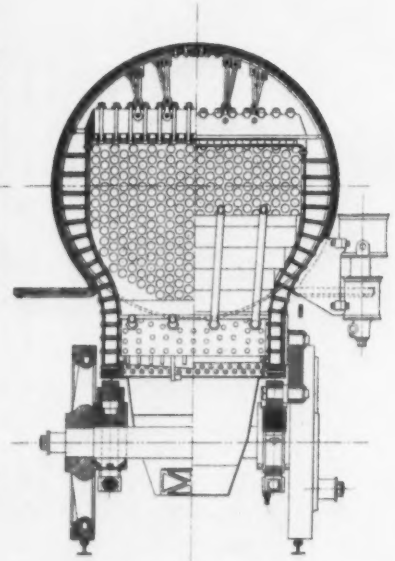


Half Section Through Truck Center-Pin. Half Front Elevation.

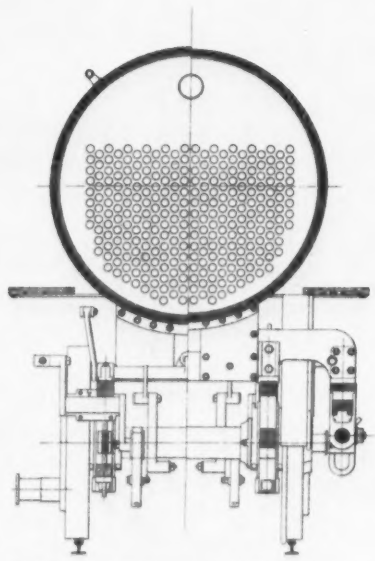
END ELEVATIONS AND SECTIONS OF COMPOUND CONSOLIDATION LOCOMOTIVE.



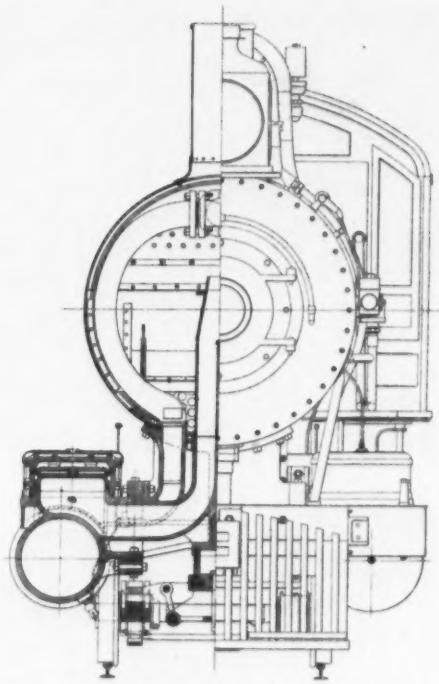
Half Section Through Rear of Firebox. Half Rear Elevation.



Half Section Through Front of Firebox. Half Section between Third and Rear Drivers.



Half Section Between First and Second Drivers. Half Section Through Guides.



Half Section Through Cylinders. Half Front Elevation.

END ELEVATIONS AND SECTIONS OF TWELVE-WHEEL LOCOMOTIVE.

FREIGHT LOCOMOTIVES EXHIBITED AT THE WORLD'S COLUMBIAN EXPOSITION BY THE SCHENECTADY LOCOMOTIVE WORKS.

Edward Ellis, President; A. J. Pitkin, Superintendent.

Scale

0 1 2 3 4 5 6 7 8 9 10 Feet.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

cessfully, and they are still there almost as perfect as on the day on which they were finished.

Very respectfully,
Alexander L. Lucas, U. S. Asst. Engineer.
Detroit, Mich., Sept. 18, 1893.

A WEAK FLOOR CONSTRUCTION.

Sir: Some of our Montreal architects are evidently not very good at figures. Let me give you an instance: A church is now being built on Dorchester St., where the main floor beams, 16 ft. apart and 32 ft. span, are made of two pieces of white pine 16 ins. × 4 ins., with a steel plate 16 ins. × ½ in. placed between, all strongly bolted.

If we take 1,000 lbs. per sq. in. on extreme fiber for white pine and 16,000 lbs. for steel we can see that the product of strains on extreme fiber by the moment of inertia of section is the same for 16 ins. × 8 ins. timber and 6 ins. × ½ in. plate. Also, the deflection under a certain load will be the same for either 16 ins. × 8 ins. timber and 16 ins. × ½ in. steel. The formula

$$y = \frac{5\,p\,a^4}{384\,E\,I}$$

proves it if we make E = 32,000,000 for steel and 2,000,000 for timber.

I only bring in the preceding few lines to show that under the given strains on the extreme fiber the bolts will have no effects on the flexure.

Now, let us see the strength of the above compound beam. The moment of inertia $\frac{b\,h^3}{12}$ of a rectangle 16 ins. × 8 ins. is 2,734.

We have the formula:

$$s = \frac{m\,v}{I}$$

$$1000 = \frac{M \times 8''}{2734}$$

$$\frac{2734000}{8} = M = p\frac{l^2}{8}$$

$$2731000 = p\,(12 \times 32)^2;$$

hence p = say 19 lbs. per linear inch of beam; this would give about 15 lbs. per sq. ft. of floor, floorbeams being 16 ft. apart. Similar calculations would give the same results for the steel plate, making in all 30 lbs. per sq. ft. of floor. In a church, counting all, this is about 1-5 of the load we should take in calculating such floorbeams.

Let us now see what size of beam would do in this case:

Load = 16 ft. × 32 ft. × 150 = 76800 lbs.

The maximum bending moment is:

$$\frac{76800 \times 32}{8} = 307{,}200 \text{ ft. lbs.}$$

The moment of resistance, if we take again the strain on the extreme fiber of 16,000 lbs. per sq. in., is

$$\frac{307200}{\frac{16000}{12}} = 230.$$

An I beam 21¾ ins. × 7¼ ins. × ¾ in., European section, would have answered better, its moment of resistance being 222.

Yours sincerely,
G. Avila.

Montreal, P. Q., Oct. 3, 1893.

SCHENECTADY FREIGHT LOCOMOTIVES AT THE WORLD'S FAIR.

(With inset.)

One of the most noticeable features of the very extensive exhibit of modern American locomotives at the World's Columbian Exposition is the enormous size of the latest designs of freight engines, combined with extreme simplicity in design and finish. The Schenectady Locomotive Works, of Schenectady, N. Y., have an exhibit of four engines, as described in our issue of May 25, 1893, and two of these are heavy and powerful freight engines, the drawings of which are given on our inset sheet this week. Of these two engines, one is a two-cylinder compound of the consolidation type, built for the Mohawk & Malone R. R.; and the other is a simple engine of the twelve-wheel or mastodon type, built for the Duluth & Iron Range R. R. Both of these engines have a very serviceable and business-like appearance, with little fine finish or decorative work, in which respects they differ essentially from foreign locomotives. In the form of dome, smokestack and sandbox they indicate the modern tendency to eliminate moldings and fancy work. The boilers are jacketed with planished Russia iron, and the other parts of the engines are painted black, with a minimum of gilt striping and lettering. We are indebted to Mr. A. J. Pitkin, Superintendent of the works, for the drawings from which our inset has been prepared.

The consolidation engine of the Mohawk & Malone R. R. is on the two-cylinder compound system which the Schenectady Locomotive Works have made a specialty, using the intercepting valve invented by Mr. Pitkin, and described and illustrated in our issue of April 20. The guides are of the Laird type, and the main rods are of I-section, while the side rods are flat, and have solid ends. The motion of the reversing shaft is eased by means of a coiled spring at the end of a rod connected to a small arm on the shaft. The boiler is of the wagon-top pattern, with long firebox above the frames, and an extension front smokebox. The piston rod is carried through the front cylinder head, being inclosed in a sheet iron jacket. The third axle is the main driving axle, and the second and third pairs of driving wheels have blind tires. The check valve is outside, and the pipe leading to it is placed low down, so that the fireman cannot use it to stand on to reach the sandbox, a proper step for this purpose being riveted to the boiler. The engine is fitted with the Westinghouse brake pump and the American driver brake.

The twelve-wheel engine of the Duluth & Iron Range R. R. is of a type which has come into considerable use for heavy freight service during the last few years. It is a simple engine, its details strongly resembling those of the consolidation engine above described. It has Laird guides, main rods of I-section and flat side rods with solid ends, while the reversing shaft is fitted with the same spring arrangement. The second axle is the main driving axle, and the second and third pairs of driving wheels have blind tires. The boiler is straight, with the dome in front of the firebox. The engine is fitted with the New York brake, with duplex air pump and a brakeshoe to each driving wheel.

Full particulars of the dimensions of these engines were given in our issue of May 25, from which we abstract the following list of leading dimensions:

	D. & I. R. R. R. Mastodon.	M. & M. R. R. Consolidation.
Driving wheels	4 ft. 6 ins.	4 ft. 3 ins.
Truck wheels	2 ft. 4 ins.	2 ft. 6 ins.
Wheel-base, driving	15 ft. 6 ins.	14 ft. 0 in.
" " truck	6 ft. 0 in.	....
" " total	25 ft. 4 ins.	21 ft. 7 ins.
Weight, on drivers	139,000 lbs.	132,000 lbs.
" on truck	30,000 lbs.	17,000 lbs.
" total engine	169,000 lbs.	149,000 lbs.
Cylinders, h. p.	22 × 26 ins.	22 × 26 ins.
" l. p.	....	32 × 26 ins.
" dist. c. to c.	7 ft. 2 ins.	7 ft. 2 ins.
Boiler, type	Straight	Wagon-top
" diam. inside	6 ft. 0 in.	5 ft. 2 ins
" barrel plates	⅝ and ¹³⁄₁₆ ins.	¼, ⅝ and ⅝ in
" tube plates	½ in.	½ in.
" rail to c. line	8 ft. 2½ ins.	7 ft. 10½ ins
Working steam pressure	180 lbs.	180 lbs.
Firebox, length	10 ft. 0⅛ in.	9 ft. 0⅝ ins.
" width	3 ft. 5⅝ ins.	3 ft. 5⅝ ins.
" depth	5 ft. 2¾ ins.	5 ft. 2¾ ins.
Grate area	34.5 sq. ft.	31.1 sq. ft.
Tubes, number	289	301
" diam. outside	2¼ ins.	2 ins.
" length	13 ft. 6 ins.	12 ft. 0 in.
Heating surface, tubes	2,212.6 sq ft.	1,878.0 sq. ft.
" " firebox	189.7 sq. ft.	162 2 sq. ft.
" " total	2,402 3 sq. ft.	2,040.2 sq. ft.
Smokestack, smallest diam.	16 ins.	14 ins.
" ht. from rail	14 ft. 10 ins.	14 ft. 5 ins.

RAILWAY CARS AT THE WORLD'S COLUMBIAN EXPOSITION.

The exhibits of American cars at the Exposition are a thoroughly representative and creditable collection of passenger and freight rolling stock. The passenger cars of the early railways show how soon American builders broke away from the coach-body style of construction. This was used in the Mohawk & Hudson R. R. cars of 1831, and the Boston & Providence R. R. cars of 1834; but the Camden & Amboy R. R. cars of 1836 had swiveling trucks, end doors and platforms, and a central aisle with transverse seats on each side.

In modern passenger cars the 80-ft. cars of the New York Central & Hudson River R. R. are probably the finest day cars yet built, and the interior work is specially commendable for its simplicity and handsome appearance. In regard to palace cars (dining and drawing-room cars), however, while the construction is in general excellent, we must express our disappointment at the interior fittings and decorations. It is true that in themselves these are very beautiful, but it is equally true that they are entirely inappropriate for railway cars. There is also too great a profusion of carving and gingerbread gilding, particularly in the Wagner and Pullman cars, while stucco ceilings are entirely out of place. The Krabel cars also offend in adopting the old style of numerous curtains and hangings which hold the dust and obstruct light. We cannot but feel surprised that carbuilders so signally fail to recognize the fact that comfort, light and elegant simplicity are the requirements of a railway car, and still continue to use a misplaced, and sometimes meretricious, style of finish and decoration. In freight cars there is little novelty, but most of the cars represent first-class modern standards of construction. Automatic couplers, air-brakes, metal brakebeams, etc., are almost universal.

Historical Cars.

The earliest passenger cars of American railways were those built in 1831 by John Goold, of Albany, N. Y., for the Mohawk & Hudson R. R., the drawings for which were made by Mr. John B. Jervis, then Resident Engineer. Three of these cars are exhibited by the New York Central R. R., and consist of small coach bodies supported upon old-fashioned leather thoroughbraces. There are three inside seats, two outside seats, and at each end a seat for the brakeman, with a lever for operating brakeshoes on one side of the car. The cars are painted a dull chocolate brown, with dark green wheels, although in an oil painting of the opening of the railway the cars are represented as being colored a bright yellow.

The following specification and agreement, written by Mr. Goold (the original of which is exhibited), is interesting:

To the Commissioner of the Mohawk and Hudson Rail Road Company.

Sir—I propose and agree to furnish for said Rail road Company, Six Coach tops—That is—to furnish jacks and jack bolts and braces with thorough braces, and put them on the frames of the company's Rail road carriages to support the coach tops. The coach tops to be finished and hung in the style of workmanship generally adopted in Albany and Troy for post coaches. The materials and workmanship to be first quality. A baggage rack and Boot to be hung at each end. The length of coach body to be seven feet and four inches—Five feet wide in the centre and three feet eight inches between the jacks. The general plan of the coach to conform to the plan and explanation given by the engineer of the company. To have three inside seats—the backs of the end seats to be stuffed with moss and all the seats to be stuffed with hair. To have a door on each side. To have an outside seat on each end across the top of the coach, with suitable footboard. Also a seat at each end for driver or brakeman, to drop below to a suitable height to make the rack his footboard. An oil cloth to be rigged to the centre rod on coach top to cover baggage, and one at each end rolled to the back of the seat to protect it from rain. The whole completed and to be hung on the carriage frames at some point on the line of said Rail road, as follows—Two coaches to be hung by the first day of July next and the remaining four by the first day of August next. The work to be subject to the inspection of the Engineer of the said Rail road company. The whole to be complete as aforesaid for the sum of three hundred and ten Dollars each. It is understood that the above coaches are not to be provided with Lamps or mud leathers.

Albany. 23d. April. 1831.

A Boston & Providence R. R. car which ran between Boston and Dedham, Mass., in 1834, is exhibited by the Old Colony R. R., and resembles the Mohawk & Hudson R. R. cars on a larger scale. The body is painted black, with gold striping and red wheels.

The American type of car appeared two years later in the cars which were built for the Camden & Amboy R. R., in 1836. The two cars exhibited by the Pennsylvania R. R. have four-wheel trucks resembling in general form the M. C. B. standard frames and pedestals of to-day. The axles have outside bearings and light coil springs over each axle box. Brakes are fitted to one truck of each car, and the brakebeam hangers are leather straps with buckles. The brakeshoes are of wood, faced with a metal plate. The couplings are links of square iron, about 24 ins. long, with the sides pressed together at the middle, forming two loops. The coupling link passes through a fixed heavy drawhead or buffer block on each car, projecting beyond the car platform, and is fastened by a vertical pin dropped into a hole in the drawbar, which is the stem of the drawhead. The seats are arranged as in a modern car, have reversible backs and are upholstered with a light brown cloth. There is seating capacity for 48 passengers. Glazed windows, 8½ ins. wide, alternate with openings 18 ins. wide, fitted with vertically sliding wooden shutters, and above these openings are ventilating panels turning on a horizontal axis. The windows have light blue curtains nailed to the top and looped up by a cord, while at each end of the car one of the windows has a glass case

and tin socket for a candle, serving as a car lamp and a signal, like the street car lamps of to-day.

The Harlan & Hollingsworth Co., of Wilmington, Del., shows a car built by it in 1836, which is of the same general type as the Camden & Amboy R. R. cars, both as to the body and the trucks. One of the trucks has inside hung brakes with wooden brakeshoes faced with metal, operated by a small brake wheel (with short spokes and no rim) in the usual position. On one side of the car is a longitudinal seat, with one end cut away to make room for a small stove, and on the other side are fixed transverse seats back to back (as in a modern sleeping car). The car is 32 ft. long over frame, and 37 ft. over platforms; width over frame, 8 ft. 6 ins.; wheels, 2 ft. 9 ins. diameter; truck wheel base, 4 ft. 9 ins. In a circular issued by Betts, Pusey & Harlan, in 1839, the attention of railway companies in Europe was called to the advantages of the eight-wheeled cars, of which the firm had then built 39 for passenger service and 28 for mail, baggage and freight service on American roads. The price quoted for a first-class car for 60 passengers, and having chilled cast iron wheels, was $2,400, or $100 extra for 6 ft. gage, and $125 to $250 for freight to Europe.

In strong contrast to these American cars of 1836 is a car designed and built in England in 1838, and sent to Nova Scotia with Hackworth locomotives for the Albion Mines Co., to run between Stellarton and Pictou. It is like a hack or cab, but with four small wheels under the body. There are two seats, one across each end, accommodating three passengers each.

Passenger Cars.

The most pleasing of the exhibits of modern American day coaches are the two exhibited by the New York Central R. R., built at the railway company's shops at West Albany, N. Y., for the Empire State Express. A combination buffet, smoking and baggage car is also shown. These cars have the Gould vestibule connections, and are carried on six-wheel trucks, with a brakeshoe to each wheel. The side bearings on the truck frames rest on springs, so that the motion of the body on curves is extremely easy. The Pintsch compressed gas system is used for lighting, with seven lamps in each of the ordinary cars and four in the main part of the smoking car. A lamp is also placed in a dome over each platform. The seats are by Hale & Kilburn, upholstered in figured plush of a copper red shade, and the back of each seat is fitted with a pocket, a brass rail for coats or wraps, and a brass ring for umbrellas. The smoking car is upholstered in brown corduroy. The interior finish is in mahogany, with very little molding or decoration, and the headlining is painted white. The several dimensions of the cars are as follows:

	Passenger.	Combination.
Length	80 ft. 0 ins.	77 ft. 2½ ins.
Width	10 " 2½ "	10 " 2½ "
Height	14 " 8 "	14 " 3 "
Distance, c. to c. of trucks	55 " 11 "	54 " 0 "
Truck wheel base	10 " 6 "	10 " 6 "
Wheels	3 " 0 "	3 " 0 "
Weight	95,400 lbs.	92,000 lbs.
Capacity	84	48

The Baltimore & Ohio R. R. exhibits two vestibuled cars for the Royal Blue Line express train service between New York and Washington. One of these is a combination baggage and passenger car, with a smoking-room between the baggage and main passenger sections. The other car is an ordinary day car, seating 58 persons and having a large and comfortable smoking-room at one end, as in a parlor car. The cars are carried on four-wheel trucks. The brake shafts are fitted with bevel gear. The Pintsch system of lighting is used.

The Pennsylvania R. R. shows one of its standard day cars, built at the Altoona shops. It is 60 ft. 7 ins. long over platforms, 53 ft. 5 ins. long inside, 8 ft. 10 ins. wide and 9 ft. 5 ins. high inside. The running gear consists of two six-wheel trucks with 36-in. cast iron wheels. The ends are vestibuled and have lamps over the platforms. The interior has seats for 66 passengers and there is an inclosed seat at each end for the brakeman. The monitor roof is very wide and shallow, and has five lamps of the Frost carburetor system. There are also four oil lamps. The closet has a movable label, showing "vacant" or "occupied," according to the position of the lock. The car is equipped for steam heat.

The Old Colony R. R. exhibits a vestibuled day car with four-wheel trucks, built by the Pullman Palace Car Co. The Jackson & Sharp Co., Wilmington, Del., exhibits an ordinary day car, on four-wheel trucks, being one of 30 built for the Chicago, Burlington & Quincy R. R. The Harlan & Hollingsworth Co., of Wilmington, Del., show a "club" car built for the exclusive use of a number of New York business men living at Plainfield, N. J., on the Central R. R. of New Jersey. One side of the interior is fitted with chair seats and card tables, and the other side has movable chairs and settees. A partition is built across the middle. The interior is finished in dark colors. The car is 71 ft. 6 ins. long over the frame, 78 ft. 1 in. long over the platforms, 9 ft. 6 ins. wide over the frame, and has two six-wheel trucks with 36-in. wheels and 10-ft. wheel base.

Palace Cars.

The Pullman Car Co. has two trains, one of five cars, headed by a Baldwin ten-wheel compound engine, and one of three cars, headed by a Rogers ten-wheel engine. The tender is in each case fitted with a vestibule frame connection which is bolted against the vestibule of the front car, so that in case of collision the strain is transmitted right through the frames of the entire train and the tender frame cannot (as with the usual arrangement it frequently does) rise above the car frame and telescope the lighter upper work of the car. The five-car train consists of a baggage and smoking car, dining car, compartment sleeping car, sleeping car and observation parlor car. All the cars are carried on six-wheel trucks, with a brakeshoe to each wheel, and are connected by vestibules extending the whole width of the car, the steps being covered by a hinged door. The brake wheel is in a vertical plane, against the end of the vestibule, with a bevel gear at the top of the brake shaft. The interior finish is, of course, very elaborate, and the woodwork is largely of Indian vermillion wood, which has a most beautiful color and grain like a dark crimson mahogany. Carving and gilding is used in profusion, and china vases with flowers lend additional color to the general effect. The cars are fitted with the electric light, some of the lamps having delicate gilded fernleaf holders, but the use of fringe around some of the lamps seems unreasonable. Movable electric lamps are fitted in some of the sections. In the compartment car, the private staterooms open from a corridor which runs along one side of the car for half its length, and along the other side for the other half. Each stateroom is finished in a different style and color. The observation car, at the rear of the train, has the end set back so as to form a long platform protected by sides and roof, and affording room for passengers to enjoy the scenery from this most desirable vantage point. The second train consists of a mail car and two drawing-room cars. The baggage car has an electric light plant in one corner, driven by steam from the locomotive.

The Wagner Palace Car Co. has a train of five cars built at its works, at Buffalo, N. Y., all fitted with Gould vestibules, and carried on six-wheel trucks with a brakeshoe to each wheel. The hand brakes are operated by the ordinary wheel, without bevel gear. The cars are painted a light blue, outside. The first car is a baggage, library and smoking car, with barber shop and bathroom. The interior finish is of mahogany and Circassian walnut, with dull brown leather cushions for the seats, and a stucco ceiling with designs in relief. The drawing-room car has white mahogany finish, a light stucco ceiling and figured tapestry upholstering. The compartment car is generally similar to that of the Pullman train, with each stateroom finished in an individual style. The sleeping car has ten sections in the main saloon, which is finished in white mahogany. The dining car is finished in Circassian walnut and dark leather and has far too many curtains and fringes, which catch dust, obstruct light and ventilation, and are a perfect nuisance in warm weather. The cars are lighted by electricity, with lamps to the sleeping berths, and large opal globes in the roof, each globe containing six incandescent lamps.

The Krabel Palace Car Co., of Cleveland, O., exhibits a train of three cars of a new style of interior arrangement. At one end of the car are the closets and washrooms, with a wide aisle between them. At the other end is a combined smoking-room and men's lavatory. The main saloon has movable seats like old-fashioned "ottomans," the box beneath the seat containing the material for one upper and one lower berth, and the seats and backs forming at night the two berths. The sections are separated by curtains, with light ornamental gratings across the monitor roof. The arrangement avoids the use of the fixed upper berths and gives the interior the appearance of a drawing-room car by day, but the seats are heavy and awkward, and the cars would probably be more comfortable if fitted with fixed seats and the same arrangement of upper berths. The lower berth is very close to the floor, which is not a desirable position. The upper berth is said to be longer, wider and 1 ft. lower than ordinary, and the berths are ventilated from the back. The cars are 63 ft. long, 10 ft. wide outside, weigh about 60,000 lbs. each, and have eleven sections, including the smoking-room. The most serious fault in these cars appears to be the liability that in a collision the movable seats or berths might be torn from their fastenings and piled in a heap by the shock, together with their occupants. The cars were built by the St. Charles Car Co., St. Charles, Mo. They were put in service July 27, 1892, and have been run on the Union Pacific, the Denver & Rio Grande, the New York, Chicago & St. Louis and other roads.

Freight Cars.

There is no special novelty in construction in this class, but the exhibits show modern standard types of cars for various classes of service.

Steel Frames.—The principal novelty in construction is the application of steel for framing, and two styles of such construction are shown. The Harvey Steel Car & Repair Works, of Harvey, Ill., use steel for trucks, sills and upper framing. The special features of the latest designs, which are under patents taken out by Mr. J. D. McIlwain, General Superintendent of the works, are as follows: First, the use of standard market sections of structural steel; second, facilities for renewals in case of damage by collision or otherwise; and third, interchangeability of parts. These features reduce the cost of construction and maintenance, as pointed out in an article in our issue of June 8, in which the company's exhibits were described and illustrated. The Fox Solid Pressed Steel Co., of Chicago, exhibits a flat car with pressed steel sills, truck frames, etc. There are six longitudinal sills of channel section, and the four truss rods bear against the under side of V-shaped pieces as long as the width of the car and riveted to the sills. The freight trucks have pressed steel plate frames and pedestals in one piece, with coiled springs over the axle boxes. These are now the standard type of freight truck on the New York Central R. R., and are also used by other roads. A passenger car truck with plate springs over the boxes is also shown.

Box Cars.—The Elliott Car Co., of Gadsden, Ala., has a box car for fast freight service. Sliding doors are used, and the grain door of the American Grain Door Co., Chattanooga, Tenn., is also fitted. The iron and lumber used is from raw material obtained within the state of Alabama. The Harvey Steel Car & Repair Works, of Harvey, Ill., show the box car with steel truck, sills and body framing, above referred to, which is fitted with air-brakes, the O. K. air-brake slack adjuster, made by Pratt & Letchworth, Buffalo, N. Y. (Eng. News, June 8, 1893), and the Pooley coupler. The Air-Brake Pressure Regulator Co. has a box car of 40,000 lbs. capacity and 28,000 lbs. weight, fitted with the Wolhaupter brake pressure regulating device, illustrated and described in our issue of July 27. The car is one built for the Wisconsin Central Ry., by the Missouri Car & Foundry Co., of St. Louis, Mo. The National Malleable Castings Co., of Chicago, has a box car with fittings of its manufacture. The car was built by the Michigan Peninsular Car Co., of Detroit, Mich., and has narrow end platforms with iron deadblocks, automatic couplers with Butler drawbar attachments and continuous draft timbers.

Gondola or Coal Cars.—The Bloomsburg Car Co., of Bloomsburg, Pa., has a coal car of 50,000 lbs. capacity, fitted with air-brakes, the "Beamless" brake gear (Eng. News, June 15) and the Empire coupler. The end sills are beyond the ends of the body, and the ends are hinged at the bottom while the sides are secured to stakes set in the usual metal stake pockets. The Ensign Mfg. Co., Huntington, W. Va., shows a car built for the Mexican International Ry. It has truss rods to prevent bulging of the sides. It is equipped with Schoen pressed steel center plates and stake pockets, Janney couplers and National metal brakebeams. The Harvey Steel Car Co. has a gondola car with steel frame and truck, as above mentioned. The stakes are also of steel T's. The Old Colony R. R. exhibits a car equipped with Trojan couplers, Lobdell wheels and Fox pressed steel trucks. The sides open for the whole length of the car. This car was built by the Keith Mfg. Co., of Sagamore, Mass.

Flat Cars.—The Ensign Mfg. Co. has a 41-ft flat car equipped with Janney couplers and the National hollow brakebeam. The Fox Solid Pressed Steel Co. has a 30-ft. flat car. Its carrying capacity is rated at 100,000 lbs., with a weight of 26,200 lbs.

Tank Car.—The Harvey Steel Car & Repair Works, of Harvey, Ill., show the frame of the tank car illustrated and described in an issue of June 8. The car weighs 19,200 lbs. without the cylindrical tank, which has a capacity of 8,000 gallons.

Stock Cars.—The Arms Palace Horse Car Co., of Chicago, exhibits two horse cars, one with 16 stalls, the other with 18. They were built by the Barney & Smith Mfg. Co., of Dayton, O. The Burton Stock Car Co., of Boston, shows a horse car fitted with end platforms and steam-heating pipes, and an open-sided stock car built by the Carlisle Mfg. Co., of Carlisle, Pa. The Canda Cattle Car Co., of New York city, has one of its standard cars fitted with Janney couplers, Westinghouse brakes, Universal steel brakebeams and the Canda patent drawbar attachment. It was built by the Ensign Mfg. Co., of Huntington, W. Va. The Hicks Stock Car Co., of Chicago, has a 36-ft. car equipped with the St. Louis steel coupler and Hinson draft rigging, with wheels cast in Barr's contracting chills. The car was built by the Terre Haute Car Mfg. Co., of Terre Haute, Ind. The Live Poultry Transportation Co., of Chicago, exhibits a large poultry car, sitting very low on the trucks, and having the diamond frames of the truck coming unusually close to the rail, the top arch bar being flat. The car was built by the Ohio Falls Car Co., of Jeffersonville, Ind. The Mather Humane Stock Transportation Co., of Chicago, shows a well equipped Mather car built by the Youngstown Car Mfg. Co., of Youngstown, O. It is fitted with M. C. B. coupler and Mather wedged lock, Butler drawbar attachments, Schoen metal brakebeams and center plates, Griffin wheels and the Boyden air-brake. In 1880 there was only one of these cars in service, while now there are 1,200 of them. Streets Western Stable Car Line, Chicago, shows a slat-side stock car, fitted with the Chicago steel coupler and Alsops improved car door. The lower arch bars of the truck do not reach to the tie bar, but have filler pieces between. The trucks have Griffin wheels, the Hewitt axle boxes, channel iron transoms, and plate springs.

Refrigerator Cars.—C. C. Palmer, of Englewood, Ill., shows a model of a mechanical refrigerator car in which no ice is used. The American Car Co., of Basic City, Va., has a ventilated fruit car for fast freight service, as built for the Chesapeake & Ohio Ry. The American Refrigerator Transit Co., of St. Louis, has a car built at its own works fitted with Safford coupler and Butler draft rigging. The Anglo-American Provision Co., of New York, Chicago and London, has a car built at its Chicago works, and having the Duechting-McGray refrigerating system. The trucks are fitted with Clarke's safety spring steel wheel fenders (F. H. Clarke, Springfield, O.), consisting of a heavy steel wire attached to the front end of each truck tie-bar and having a coiled end bent round to project across the rail. The Eastman Car Co., of Boston, Mass., has two cars built at its own works. One of these is of 50,000 lbs. capacity, fitted with air-brakes and the Williams coupler, and carried on Fox pressed steel trucks. The other is a combined heater and refrigerator car, with a vacuum chamber between the walls of the icebox and having arrangements for maintaining a dry atmosphere. The stove for heater purposes, when the car is carrying fruit, etc., in cold weather, is placed beneath the floor, and the Eastman automatic thermostat is fitted which regulates the temperature within the car at any desired point. The Hutchinson Refrigerator Car Co., of Chicago, has a fruit car of the California Fruit Transportation Line, and a beef car, both built on the C. B. Hutchinson patents by the Michigan-Peninsular Car Co., of Detroit, Mich. They are both of 50,000 lbs. capacity. The fruit car has Gould couplers with W. H. Miner's draft rigging and the Detroit metal brakebeam. The beef car has the Chicago coupler with W. H. Miner's draft rigging and King's patent angular metal brakebeam (Eng. News, May 4, 1893). The Merchants Dispatch Transportation Co., of New York, has a car with the Fox pressed steel truck and the automatic coupler of the Standard Car Coupler Co., of Troy, N. Y. The tanks hold 4,500 lbs. of ice. Nelson Morris & Co., of Chicago, have a car designed and built under their own patents at their shops, at Forty-seventh St. and Halsted St. The Pennsylvania R. R. shows its standard refrigerator car of 60,000 lbs. capacity, built at its Altoona shops. The United States Car Co., of Chicago, shows a 60,000-lb. car with Hanrahan's system of refrigeration. It has air-brakes, Drexel couplers and continuous draft gear.

Logging Cars.—The Russell Wheel & Foundry Co., of Detroit, Mich., shows different styles of logging cars and trucks in the annex of the Transportation Building and at the Michigan logging camp in the grounds. Some of the cars have 20-in. wheels with journals 2¾ × 5⅝ ins., and weigh 46,000 lbs. Larger trucks have 24-in. wheels, journals from 3 × 5½ ins. to 3¾ × 7 ins., and weigh 8,000 to 9,500 lbs.

Freight Cars at the World's Columbian Exposition.

	Length, lbs.	Weight, lbs.	Capacity, lbs.
Box Cars.			
Harvey Steel Car Co., Harvey, Ill..	34.0	28,700	60,000
Missouri Car & Foundry Co., St. Louis, Mo. (Wisconsin Cent. Ry.).	33.6	28,000	40,000
Michigan Peninsular Car Co., Detroit, Mich. (National Malleable Casting Co.)	....	29,800	60,000
Elliott Car Co., Gadsden, Ala.	....	32,900	60,000
Gondola Cars.			
Bloomsburg Car Co., Bloomsburg, Pa.	..	.....	50,000
Ensign Mfg. Co., Huntington, W. Va. (Mexican International Ry.).	....	25,800	60,000
Harvey Steel Car Co., Harvey, Ill..	34.0	24,350	60,000
Old Colony R. R (Keith Mfg. Co., Sagamore, Mass.)	....	24,200	60,000
Flat Cars.			
Ensign Mfg. Co., Huntington, W. Va	41.0	23,000	60,000
Fox Solid Pressed Steel Co., Chicago, Ill.	30.0	26,200	100,000
Stock Cars.			
Burton Stock Car Co.; Carlisle Mfg. Co., Carlisle, Pa.	36.0	32,900	30,000
Canda Cattle Car Co.; Ensign Mfg. Co., Huntington, W. Va.	...	32,900	44,800
Hicks Stock Car Co.; Terre Haute Mfg. Co., Terre Haute, Ind.	36.0	31,700	40,000
Live Poultry Transportation Co.; Ohio Falls Car Co., Jeffersonville, Ind.	33.1	.....	.....
Mather Humane Stock Transportation Co.; Youngstown Car Mfg. Co., Youngstown, O.	....	34,500	50,000
Street's Western Stable Car Co.	36.0	29,800	60,000
Refrigerator Cars.			
American Refrigerator Transit Co.	....	33,500	50,00
Eastman Refrigerator Car Co.	....	33,200	50,00
" " " "	....	25,300	40,000
Merchants' Dispatch Transportation Co	....	39,000	40,000
Pennsylvania R. R.	....	41,400	60,000
United States Car Co.; Anniston, Ala	....	42,500	60,000

Miscellaneous Cars.

Mail Cars.—The Pullman Palace Car Co. has a completely equipped mail car on one of its exhibition trains, as above noted. The Lake Shore & Michigan Southern Ry. has two cars built at its shops at Adrian, Mich., for the United States Railway Post-Office service. They are large cars for the Fast Mail line, are carried on six-wheel trucks with all wheels braked, and are painted white. They have the Pintsch light, the Gould continuous platform and coupler, and vestibules on the platforms, but no flexible vestibule connections. The Jackson & Sharp Co., of Wilmington, Del., has also a mail car, which will be used on the Chicago, Milwaukee & St. Paul R. R. after the close of the Exposition. This car is in the post-office department of the Government Building, and is used for sorting mail, one side being removed so that visitors can see the method of operation. It has six-wheel trucks with brakes on the outside wheels only. The vertically sliding lids of the axle boxes are secured to the truck frames by light chains, which is a wise precaution in view of the number of axle boxes of this type having the lids lost and temporarily replaced by pieces of wood.

Dynamometer Car.—The Chicago, Burlington & Quincy R. R. has a dynamometer car, which is carried on two four-wheel passenger trucks with 6 ft. 6 ins. wheel base. Brakes are not fitted to the truck at the dynamometer end of the car. The interior is fitted with the recording and registering apparatus, and with a slideometer for measuring the force of shocks.

Track Inspection Car.—The Pennsylvania R. R. shows a car used for the inspection of the track by officers and employees of the road, the car being pushed slowly along by an engine. The front end is open, and the floor slopes up from this end, and is fitted with ordinary car seats, so that all the occupants may have a good view of the track. It has seating accommodation for 28 persons.

Track Indicator Car.—The Pennsylvania R. R. also shows its indicator car, which is constructed on the same general principles as Mr. P. H. Dudley's well known dynagraph or track indicating car. It is like a large caboose, carried on two axles with spoke wheels and long plate springs over the axle boxes. Behind one pair of wheels is a small pair of deeply flanged wheels connected to the mechanism of the recording apparatus contained within the car. The arrangement does not appear to be so complete or elaborate as that of Mr. Dudley's car.

Exhibition Cars.—The Northern Pacific R. R. Co.'s land department has two handsome vestibuled cars fitted up with photographs of scenery, maps, specimens of grain, agricultural and mineral products, etc., of the seven states traversed by this road. The cars were built at the company's Como shops.

Light and Heat Tender.—The Chicago, Milwaukee & St. Paul R. R. exhibits a car equipped for furnishing steam heat and electric light for trains. It is an iron car on four-wheel passenger trucks, and has wooden sheathing inside the iron plating. It is 32 ft. 4 ins. long and 8 ft. 4 ins. wide in the clear, and weighs 76,000 lbs. (with 5,000 lbs. of coal and 300 gallons of water). At one end is a locomotive tubular boiler and in the other part of the car, separated by a bulkhead, is a Westinghouse two-cylinder standard automatic engine with cylinders 6½ ins. diameter and 6 ins. stroke, developing 18 HP. with 100 lbs. steam pressure. This engine drives an Edison dynamo of 15 K. W. and 110 volts by a link belt. A Westinghouse oil separator is also used.

The car was built in January, 1890, at the railway company's shops, in West Milwaukee, and has run 190,000 miles. Two of these cars are used during the winter season on the vestibuled limited trains running daily between Chicago, St. Paul and Minneapolis. Each train consists of ten cars, and is heated by steam and lighted throughout by electricity, using 200 incandescent lamps of 15 c. p.

THE INTERSTATE COMMERCE COMMISSION'S STATISTICAL REPORT FOR 1892.

In our issue of March 30, 1893, we published a preliminary report by the Statistician of the Interstate Commerce Commission on the income account of the railways of the United States for the year ending June 30, 1892. An abstract of the full report of the Statistician for the same year has just been issued, from which we have taken the following facts of most interest:

Mileage.

The total railway mileage of the country on June 30, 1892, was 171,563 miles, or an increase of 2.03% over that of the preceding year. This is the smallest increase in railway mileage reported in a number of years. The causes of the decrease were fully discussed in connection with our map of railway construction for 1892 (Eng. News, March 2, 1893).

Classification of Railways.

The total number of railway corporations and the changes which have taken place in their organization during the year are as follows:

	Year, 1892.	Inc. or Dec. P. C. over 1891.
No. of railway corporations....	1,822	+2.04
No. of railways abandoned.....	9	—43.7
No. of railways merged.....	19	—45.7
No. of railways reorganized....	17	....
No. of railways consolidated...	16	—59.0

A classification of railway companies, according to the mileage of railway operated, gives the following results:

No. companies operating over 1,000 miles.....	43
No. companies operating between 600 and 1,000 miles	24
No. companies operating between 400 and 600 miles.	24
No. companies operating between 250 and 400 miles.	40
No. companies operating under 250 miles.....	871

The total mileage controlled by the 43 companies operating over 1,000 miles each was 99,232 miles, or 57.86% of the total mileage of the country.

Equipment.

The total number of locomotives and cars in use was as follows:

	Year, 1892.	Inc. or Dec. P. C. over 1891.
Passenger locomotives.....	8,848	+ 1.46
Freight locomotives	17,559	+ 4.07
Switching locomotives	4,355	+ 0.79
Unclassified locomotives	2,374	+ 6.93
Total number of locomotives.....	33,136	+ 3.10
Total No. of cars owned.....	1,215,092	.....
No. of cars in freight service.....	966,908	.....
No. of cars in company's service...	36,901	.....
No. of cars in fast freight service..	35,078	.....
No. of cars leased.....	140,339	— 4.61
No. of locomotives per 100 miles...	20	No. ch'nge
No. of pass. cars per 100 miles....	18	.....
No. of frt. cars per 100 miles.....	708	+ 14.4

These figures are exclusive of cars owned by private companies and leased to shippers. There was an enormous increase during the year in the number of locomotives and cars fitted with automatic couplers and air-brakes, as will be seen from the following figures:

Increase in equipment.....	27,139
Increase in equipment fitted with brakes.....	68,537
Increase in equipment fitted with couplers....	75,269
Total equipment fitted with brakes.....	236,970
Total equipment fitted with couplers.....	244,344
Total equipment.....	1,304,710

From the last three items of this table, which are calculated by adding the increase for 1892 to the figures for 1891, as given in the last report of the Statistician, it will be seen that on June 30, 1892, 19.7% of the total equipment was fitted with air-brakes and 17.6% with automatic couplers.

Employees.

The total number of employees in the service of railway companies is given at 821,415, or 1 for every 79 inhabitants. In 1891 this ratio was 1 to 82 and in 1890 1 to 84. Most of the increase in railway employment is in groups I., II., III., VI. and X.; that is to say, in the territory east of the Mississippi and north of the Ohio rivers, and on the Pacific slope. In groups IV. and VIII. there has been only a slight increase while groups V., VII. and IX. show small decreases in the number of men employed by railways.

Capitalization.

The various forms of railway capitalization are given as follows:

Stocks	$4,633,108,763
Funded debt.....	5,593,038,050
Mortgage bonds	4,602,070,933
Total capitalization	10,226,148,113
Per cent. of stock paying no dividends....	60.6
Per cent. funded debt paying no interest..	15.56

In 1891 the proportion of stock upon which no dividends were paid was 59.64% and the proportion of funded debt paying no interest, 9.9%.

Public Service.

The statistics show large increases in the number of passengers and the tonnage of freight carried, as will be seen by the following table:

	Year, 1892.	Inc. P.C. over 1891.
No. passengers carried.....	560,958	+7.48
Passenger train mileage.....	317,538	+2.85
Passengers per passenger locomotive	63,390	+ 6.2
Pass. mileage per passenger locomotive	1,510,273	+ 4.6
Tons freight carried.....	706,555	+4.57
Freight train mileage.....	485,402	+8.77
Passenger train load, passengers....	42	no change
Av. passenger journey miles.....	23.82	—5.71
Freight train load, tons.....	181.79	+0.06
Av. haul per ton, miles.....	124.89	+4.08

Earnings and Expenses.

A preliminary statement of the earnings and expenses was given in our issue of March 30, 1893, as before noted. The corrected figures of the full report are as follows:

	Year, 1892.	Inc. P. C. over 1891.
Gross earnings	$1,171,407,343	6.3
Operating expenses	780,997,906	6.74
Net earnings	390,409,347	6.99
Income from operations.....	532,370,129	6.7
Fixed charges	416,404,938	....
Surplus from operations	14,036,056	3.30
Passenger revenue	288,805,708	1.99
Mail revenue..	26,861,143	8.02
Express revenue	22,148,988	2.56
Freight revenue	799,316,042	8.50

The income account of six out of the ten territorial groups shows a deficit. These groups cover the territory lying south of the Ohio and west of the Mississippi and Missouri rivers.

Accidents.

The figures show a decrease in the number of fatal accidents to employees, but an increase in the number of passengers killed. The number of both employees and passengers injured shows a large increase. The following table shows the number killed and injured of both passengers and employees:

	Year, 1892.	Inc. or Dec. P. C. over 1891.
No. employees killed.....	2,554	— 3.94
No. employees injured.....	28,267	+ 8.17
No. employees killed coupling and uncoupling cars	378	— 8.9
No. employees killed by falling from train	611	+ 2.0
No. employees killed in collisions and derailments.....	431	—13.3
No. passengers killed	376	+ 28.3
No. passengers injured	3,227	+ 8.59
No. passengers killed in collisions and derailments	177	+ 71.8

An assignment of casualties to the opportunity offered for accidents shows:

1 employee killed for every.....	322	employees
1 employee injured for every.....	29	employees
1 passenger killed for every.....	1,491,910	passengers
1 passenger injured for every.....	173,833	passengers
1 passenger killed for every.....	35,542,282	pass. miles
1 passenger injured for every....	4,140,966	pass. miles

THE NEW YORK CENTRAL'S STANDARD STEEL RAIL SPECIFICATIONS.

We reprint herewith in full the new standard specifications for steel rails adopted by the New York Central & Hudson River R. R. Co. The specifications contain, as will be seen, a number of noticeable innovations. The variation of the carbon percentage in the rails of different weights seems a sensible improvement, for it is desirable to make the rails as hard as is safe without making them too brittle, and a 100-lb. rail is considerably less liable to breakage than a 60-lb. rail. The suggestion that rails should be so cooled that they will be high at the ends and low at the middle is also sensible, for when such a rail is straightened it will not be so likely to get down at the joints and high at the center. Stamping the rails to denote what part of the ingot they were rolled from is another innovation, and one which railmakers may be disposed to consider a nuisance. Its object, of course, is to determine the wearing qualities of the rails from different parts of the ingot. The specifications are as follows:

1. The chemical composition shall be limited for the several elements as follows:

Silicon to vary between 0.10 to 0.15; manganese to vary between 0.80 to 1.00; sulphur not to exceed 0.060; phosphorus not to exceed 0.060.

The following rails will be rejected:

65-lb. rails having carbon below 0.43 or above 0.57
70-lb. rails having carbon below 0.45 or above 0.59
75-lb. rails having carbon below 0.48 or above 0.62
80-lb. rails having carbon below 0.55 or above 0.65
100-lb. rails having carbon below 0.60 or above 0.75

From the results of inspections of the rolling of the ingots, blooms and rails, and from the drop tests, the inspector of the railroad company in charge of making the rails shall have the right to select the minimum or maximum limit of either the carbon, silicon or manganese, or the three, as the general guide for the composition, as he may consider the finished product requires to produce a tough rail with as dense fine grained heads as possible by the plant of the manufacturer.

2. The heat to be blown clean in the stack, and when poured into the ladle, to be agitated by thrusting a green wood pole into the metal for 10 seconds.

3. In teeming the ingots for rails, no cracked nor patched molds, and only a thin, even wash of "slurry" used in the molds will under any circumstances be permitted.

The molds must be filled without undue spattering, at one pouring, and must be maintained in a vertical position until the upper portion—top—of the ingot has solidified.

Ingots which have bled—"bleeders"—or from chilled heats or have been badly teemed, will not be permitted to be charged into the furnaces or be used for rails under any circumstances.

4. From each heat two test ingots shall be cast, 2½ × 2½ × 4 ins. long.

One test ingot taken from the metal going into the first ingot poured from the heat shall be marked "A," and the second test ingot from metal going into the final ingot shall be marked "B."

As may be designated, either "A" or "B" test ingot or both shall be rolled into bars ½ in. square, and pieces 18 to 20 ins. long will be required to bend to a right angle without breaking.

Any form of test bar of about the size mentioned will be accepted, which, in bending either to a right angle of 160°, will stretch the metal on the outside of the bend about 12% per in. The bars, however, must be rolled and bent by blows from a sledge or hammer.

5. In reheating the ingots, or blooms, care must be taken to avoid overheating or producing a coarse texture in the head of the finished rail. In no case shall they be reheated until the cinder starts to run when the ingot or bloom is drawn from the furnace or soaking pit.

6. The sand or top end of each bloom to be cut or sheared off until sound and solid steel is obtained entirely free from sponginess, pipe or exterior scabs. This matter must have special attention on the part of the manufacturer.

7. The section of the rail throughout its entire length shall conform to the template to be made in strict conformity with the measurements or dimensions on the drawing or blueprint of the section hereto attached or designated. The fit of the fishing or male template shall be perfectly maintained.

When the rolls are new the section of the rail must be of its standard height. As the rolling proceeds a variation not exceeding 1-64 in. of excess in height may be permitted in a delivery of 10,000 tons of rails in any one section, after which rolls must be reduced to the standard height for such section. The standard of measure to be Darling, Brown & Sharpe U. S. standard steel rules.

8. The rails to be rolled at as low a heat as possible.

9. The weight of the rail shall be determined by the top rail of the ingot, and shall be maintained as near to standard weight per lineal yard as is practicable in conformity with the provisions in Clause 7.

10. The standard length of rails shall be 30 ft. at a temperature of 70° F. Shorter rails of 24-ft. lengths or over will be accepted to the extent of 10% of the entire order. A variation in length not exceeding ¼ in. longer or shorter than the above specified lengths will be allowed.

11. The saws must be kept sharp, and care must be taken in sawing to avoid a flow of steel which will produce a swell in the center of the head, or on top of the flanges of the base.

12. Rails must not be overcambered to cool; on the contrary, rails which on a circular curve are concave ½ in. at the center are preferred.

13. Rails, when placed on the hot beds, must be spaced at least 8 to 12 ins. apart until cool enough to be sent to the straightening presses.

14. Cold "gagging" the rails severe enough on the head or base to leave the impression of the "gag" will not be permitted. The distance apart of the supports in the straightening press must be suitable for the stiffness and section of the rail, as follows:

For the 65 and 70-lb. sections, not less than 36 ins. c. to c. of supports.

For the 75 and 80-lb. sections, not less than 40 ins. c. to c. of supports.

For the 100-lb. sections, not less than 44 ins. c. to c. of supports.

The supports on the straightening presses must be flat, not worn hollow, and set on the presses, "out of twist," having recessed fillets in the corners.

The rails must be straight in all directions, as to both surface and line, without twists, waves or kinks, particular attention being given to having the ends without kinks or drops. No rails shall be straightened until they have cooled so they can be handled with the bare hands.

15. The rails must be smooth on the heads and bases and free from all mechanical defects, flaws and seams, and must be sawed square at the ends. The burrs made by the saws carefully chipped and filed off, particularly under the head and top of the flange, to ensure proper fit of the splice plates.

16. Drilling for bolts to be in strict conformity with the blueprint attached, or the dimensions given herewith. Holes imperfectly drilled to be filed to proper dimensions. All holes must be accurate in every respect, and finished without burrs.

17. The name of the maker, date, year and month, with the designation of the rail, to be rolled on the side of the web. The number of the heat to be stamped on the side of the web so as not to be covered

by the splice plates. The rail from the top of the ingot to be also stamped "A," the second rail "B," the third rail "C," the fourth rail "D" and the fifth rail "E."

18. One rail butt, at least 4½ ft. long, to be taken from each heat, and placed upon skids, side by side, to cool. The heat number to be stamped upon each. If the heat exceeds nine tons, then two rail butts are to be taken if the inspector so desires.

The butts, when cool, to be placed, either head or base upward, on solid steel or iron supports, and upon them shall be dropped a weight of 2,000 lbs.; the height of drop and distance apart of supports for the different weight of rails being as follows:

Weights per yd.	Height of drop.	Distance apart of supports.
60	16 ft.	3 ft.
65	16 ft.	3 ft.
70	16 ft.	3 ft.
75	20 ft.	4 ft.
80	20 ft.	4 ft.
85	20 ft.	4 ft.
90	20 ft.	4 ft.
95	20 ft.	4 ft.
100	20 ft.	4 ft.

Ninety per cent. of such tests must stand without breaking, and the rails of any heat in which the broken butts do not show an elongation of 5% in the inch under greatest tension are to be held until a piece can be cut from another rail and tested under the drop. If this fails to show the 5% elongation before breaking, it shall subject to rejection the entire lot of rails made from that heat.

19. The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when this contract is being filled, to satisfy himself that the rails are being made in accordance with these specifications. The manufacturer shall daily furnish the carbon determinations of each heat, and a complete chemical analysis of at least one heat of each day and night turn in which each element is to be determined.

20. Inspectors shall have power to reject rails made from insufficiently sheared blooms, or from heats the test butts of which have failed, or from badly poured heats or from "chilled" heats or from "bled" ingots.

21. Care to be taken in handling the rails during manufacture so as not to bruise the flanges or throw or let the rails fall upon each other. In loading upon the cars they must be skidded into them and not thrown in, or allowed to fall from any height.

Approved by Walter Katte, Chief Engineer.

RECENT PAPERS ON FOUNDATION CONSTRUCTION.

The following gives the most important facts presented in recent papers on foundations read before various engineering societies:

Bridge Superstructure and Foundations in Nova Scotia.

During the last few years the use of concrete for highway bridge abutments and piers has obtained much favor in Nova Scotia, owing largely to the efforts of Mr. Martin Murphy, M. Am. Soc. C. E., Provincial Government Engineer. There have been 147 highway bridges of metal superstructure and concrete foundations built within 10 years, 44 of which have been standing for five years. The use of concrete foundations is also being rapidly extended to railway bridges. These foundations have been subjected to heavy drift ice and to the extremes of climate, and but one failure has been recorded; this one was undoubtedly due to improper workmanship. The work is done under the supervision of the government engineers, and generally by men trained in the use of concrete. The cost of concrete work in bridge piers and abutments varies from $5.50 to $6.50 per cu. yd., and from $7 to $8 in arched bridges. The aggregates used vary according to the material most easily obtained in the neighborhood of the work. They are for the most part the natural gravels. Large rubble stones are commonly used imbedded in the concrete. The cement used is English Portland.

The construction of concrete foundations varies, of course, with the conditions of the foundation bed. On rock, iron or steel cylinders are commonly used. A crib containing voids for the cylinders is sunk over the pier site, and holes are drilled into the rock in which iron rods are placed. The cylinder is then placed outside of these rods and filled with concrete. The voids in the crib surrounding the cylinder are also filled with concrete. Where quicksand covers the rock it is first removed and then a mattress of brush and small stones is sunk, through which piles are driven and the cylinder is placed on them. The space between the piles is filled with concrete, and the piles directly under the cylinder are allowed to extend up into the cylinder several feet. Cribwork and piles are also used in clay. In some cases caissons resting on piles, upon which a monolith of concrete is built, without cylinders, are used. It is stated in the paper read before the International Engineering Congress by Mr. Murphy, from which the above matter has been abstracted, that these foundations withstand the action of the climate and the shocks of drift ice better than masonry and that they are much cheaper.

Monolithic Construction Under Water by Cement Grouting.

The possible applications of cement grout in constructing masonry submerged in sea water are discussed in a practical paper read before the International Maritime Congress, in London, England, by Mr. W. R. Knipple, M. Inst. C. E. Briefly stated, the process described consists in forcing cement grout under a head into the interstices of, say, a breakwater built of concrete blocks. The grout displaces the water, and when set makes a monolith of the whole structure. Mr. Knipple first experimented with boxes filled with shingle and placed under water at depths up to 20 ft. Cement grout was poured into a pipe which had been inserted into the shingle. It was found that the grout displaced all the water in the box and hardened into a solid block with the shingle. The grout filled the smallest interstices, even showing the grain of the rough sawed timber of which the boxes were constructed. After these experiments the process was successfully used in several actual structures, among the most important of which may be mentioned the Hermitage Breakwater, St. Helier, on the island of Jersey. The dimensions of this breakwater were: Length, 525 ft.; average height, 68 ft.; width of base, 50 ft., and width of top, 42 ft.

For about two-thirds of the length granite rock was exposed, and for the remaining third the rock was covered with a bed of sand and clay varying from a few inches to 8½ ft. in thickness. This earth was removed and the trench filled with rubble stone and shingle to a height necessary to make the foundation level. Cement grout was then forced into the filling through pipes placed from 8 ft. to 10 ft. apart. The grouting was done in sections 12½ ft. in length, from a week to 10 days being taken to complete each.

Upon the foundation the superstructure, composed of concrete blocks 4×4×9 and 12 ft., was laid in sloping courses inclined to the horizontal at an angle of 68°. The first four courses were laid by divers. The blocks were stacked dry on top of each other for two courses in height at a time and three in length, which formed a 12½-ft. section. When these had been laid, the horizontal and vertical joints were calked below water by divers and above water by the masons. The grouting was then done as already described. When two courses of blocks had been laid and grouted, two more were begun, and so on. The grouting was done in 50 ft. of water in places.

In preparing the grout and passing it through water, care is necessary in order to obtain satisfactory results. It is important that the cement should be finely ground, the test for fineness being that 90% must pass through a sieve of 6,400 meshes per sq. in. It is also found that a new cement sets much quicker under water. The grout should be of the consistency of a thick paste. A half column of grout will balance a full head of water; that is, a 30-ft. column of grout will balance a 60-ft. head of water. It is advantageous to keep the spread of the grout within narrow limits, placing the pipes, say, from 8 ft. to 10 ft. apart.

Rubble Blocks in Concrete Structures.

Varying opinions are held by engineers regarding the comparative advantages and disadvantages of using rubble stone replacers in concrete work. In a recent paper published in the Proceedings of the Institution of Civil Engineers, Mr. John W. Steven describes three large concrete structures where rubble replacers were used, and deduces some interesting facts regarding cost, rapidity of construction, etc. The comparative costs of ordinary concrete and rubble concrete in the three structures are given as follows:

	Conc'rte, cost per cu. yd. $	Rubble concrete, cost per cu. yd. $	Saving. $	Cost of concrete saved. P. c.	Rubble present in rubble conc'rte. P. c.
Ardrossan harbor	6.00	5.00	1.00	16.7	20.0
Irvine branch	7.00	3.68	3.32	48.0	63.6
Calanas & Tharsis Ry	7.08	3.43	3.55	18.0	30.3

The percentage of saving effected is less than the percentage of concrete displaced, because the cost of the rubble which takes its place has to be added, and, further, because the cost of building is practically constant in both. The richness of the concrete also affects the proportion of the saving; for example, if rubble costing $1 per cu. yd. be used to displace 25% of concrete costing only $2.50 per cu. yd., with a building constant of, say, 50 cts., the saving effected would only be the difference between $3 and $2.62, namely, 12¼%. It is thus evident that by the addition of rubble a marked saving can be effected, while retaining the advantages of a rich and strong concrete.

Foundations in "Black Cotton" Soil in India.

The construction of foundations in what is known as the "black cotton soil," in India, is described in a paper before the Institution of Civil Engineers by Mr. Evelyn H. Young. This soil is a disintegrated trap full of fissures and holes which fill with water during the rainy season and cause the soil to swell and assume a pasty condition, very destructive to masonry foundations. The common methods followed in building foundations in this material are: (1) Where the building is small and the "black cotton soil" thin, excavate the entire area to the firmer soil underneath and fill with a suitable material, as sand, cinders, etc. (2) Where the soil is deeper sink pillars to the firm soil and support the walls on jack arches springing from them. (3) Where the soil is too deep for this excavate an area a little larger than the building about 10 ft. deep, fill 5 or 6 ft. with a suitable material and lay a floor of concrete 2 to 3 ft. thick on this and construct the masonry on the concrete. (4) Where a less expensive foundation than the latter is required, use a skeleton iron frame, with the uprights resting on concrete bases, to support the roof and build the walls on a separate foundation.

The whaling steamer "Newport" is reported to have reached 84° north latitude, sailing north from Herschel Islands. The highest latitude before reached, and duly authenticated was 83° 24' north latitude, 44° 5' west longitude, reached by Lieutenant Lockwood and Sergeant Brainerd, of the Greely expedition, on May 13, 1884.

A funeral car propelled by electricity is the latest innovation in that line. About nine miles from San Francisco are four large cemeteries and a crematory. The enterprising owners of the electric line connecting these with the city have fitted up a special funeral-car and provide a train for the mourners; the whole train switches on to a siding inside the cemetery gates. Practically the same thing was done in the City of Mexico at least ten years ago. But mules were used for traction purposes instead of electricity.

The ill-fated and unfinished Mackaye Spectatorium, near the World's Fair grounds in Chicago, is being torn down. The sum of $550,000 was expended upon it, and it was sold for $2,250. It is estimated that there are in the building 1,200 tons of iron, but that it will cost $15,000 to tear it down and remove it. The purpose of the builders in erecting it was fully explained in Engineering News of Aug. 24 last.

The improvement of the harbor of Tampico, Mex., by the new jetties is shown by relief models in the exhibit of the Mexican Central Ry., in the Transportation Building, at the World's Columbian Exposition. The town of Tampico is situated some short distance above the mouth of the Panuco River, and beyond the shore line the average depth of water was but 8 ft., the water from the river losing its velocity in spreading over a wide area, and thus depositing the matter held in suspension. The mean range of tide is 14 ins. The construction of the jetties confining the current to a narrow channel resulted in scouring out the bottom to a minimum depth of 20 ft. between the jetties by December, 1892, thus enabling large vessels and steamers to enter the river and go up to Tampico, which is an important terminal point of the Mexican Central Ry. Mr. E. L. Corthell, late chief engineer of the harbor work, wrote us in September last that there is now no inner bar, while the outer bar has 22½ ft. of water, which admits practically all vessels that navigate the

Gulf of Mexico. and establishes Tampico as the best gulf port west of New Orleans. The maximum depth of water required by the concession granted by the Mexican Government to the railway company is 22 ft. The jetties are of pile trestle and stone.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BAI DES CHALEURS.—M. J. Hogan, contractor, has just completed the section from the 60th to the 80th mile post, the work has been received by the government engineer and payment of the subsidy recommended. The projected line is from Metapedia, Que., to Paspebiac, Que., 100 miles, and it is stated that the remaining 20 miles will be built as soon as possible. Pres., J. R. Thibaudeau, Montreal.

BALTIMORE & CUMBERLAND.—A dispatch from Hancock, Md., states that the engineering corps which has been at work between Hagerstown and Cumberland since spring, with headquarters in that city, has returned home and that the office will soon be closed. It is reported, however, that the construction of the road will be commenced in March.

BANGOR & AROOSTOOK.—The first inspection train was run over this road Oct. 6. The rails are laid to North Twin Dam, 30 miles beyond Brownville, Me., and the ballasting nearly completed to that place. The work is progressing rapidly and it is thought that trains will be running to Houlton by the middle of next month.——It is stated that the citizens of Patten have offered to grade the roadbed, furnish the ties, lay the rails and grant the right of way if the company will build the five-mile branch to that place, referred to last week.

CHICAGO & EASTERN ILLINOIS.—About 22 miles of track have been laid and the entire 35 miles of grading completed on the branch from Rossville to Sidell, Ill.

CINCINNATI, JACKSON & MACKINAW.—A press report states that important extensions will be considered at the stockholders' meeting to be held at Toledo next month. The proposition is to continue the road from Franklin, O., to Cincinnati by buying the Cincinnati, Lebanon & Northern Ry. roadbed and right of way into Cincinnati. Also to extend the road from Addison, Mich., to Jackson, making that city its northern terminus. The right of way to Jackson has already been secured.

DRUMMOND COUNTY.—A branch of this railway is being built in Quebec from St. Leonard, on the main line, to Levis, opposite Quebec. The line extends through about 50 miles of line timber land and it is expected that about 30 miles of the road will be constructed by the end of this month. At Levis a connection will be made with the Intercolonial Ry., which will thus be given a direct route to Montreal. Gen. Man., Wm. Mitchell, Drummondsville, Que.

GEORGES VALLEY.—The construction of this railway from West Warren, Me., connecting with the Maine Central R. R., north to lime kilns and quarries at South Union, Me., a distance of about eight miles, is nearly completed. Ch. Engr., Wm. Lee, Buckport; contractor, James Mitchell, West Warren, Me.

MIDDLESEX VALLEY.—This railway is being extended from Stanley, N. Y., to Geneva, a distance of eight miles. The line is about all graded and the extension will probably be completed by Jan. 1, 1894. Ch. Engr., R. F. Uniacke, Naples, N. Y.

OLD COLONY.—The proposed railway between Falmouth, Mass., and Hyannis is again being considered. It would follow the coast the entire distance and connect with the Old Colony R. R. at each terminus. Frank A. Nye, North Falmouth, Mass., is interested.

PENNSYLVANIA.—A press report from Chapel Point, Md., states that engineers in charge of A. Feudpauche and Geo. Tatnall have been surveying for an extension of the Pope's Creek branch to that place.

PORTLAND & RUMFORD FALLS.—Tracklaying has been commenced on the extension of this railway, from Mechanic Falls, Me., eastward to connect with the Maine Central R. R. near Auburn, a distance of about 12 miles. The work was commenced early in the spring and will probably be completed within a few weeks.

WILLIAMSPORT & NORTH BRANCH.—The extension of this road from Nordmont, Pa., to connect with the Lehigh Valley R. R. near Bernice, a distance of 18 miles, has been completed and opened for traffic.

Projects and Surveys.

SOUTH SHORE.—It is reported that Louis Tourville, Joel Leduc, J. M. Fortier and Hyacinthe Beauchemin have applied for an act of incorporation for this company to build a railway from Levis, Que., to Valleyfield to connect with the Canada Atlantic Ry. and passing through the counties of Levis, Lolbiniere, Nicolet, Yamaska, Richelieu, Vercheres, Chambly, La Prairie, Chateauguay and Beauharnois.

Southern—Existing Roads.

ALTAMONT & MANCHESTER.—This railway was completed in the spring from Altamont, Ky., to Lucell, a distance of three miles, and it is reported that construction may be resumed this fall on the remaining 22 miles to Manchester, Ky. Pres., C. Crooke, Altamont, Ky.

FLORIDA CENTRAL & PENINSULAR.—This company has leased or purchased the entire line of the South Bound R. R., extending from Savannah, Ga., to Columbia, S. C., a distance of 142 miles, which gives it, in connection with the extension now being built a direct route from Jacksonville, Fla., to Columbia. The construction of this extension from Hart's Road, Fla., north of Jacksonville, to Savannah, a distance of 114 miles, was commenced last May and the road will probably be completed in about two months. Some weeks ago the company became dissatisfied with the progress being made and the remainder of the track will be laid by the company. The roadbed was seriously damaged by recent storms, but this is being repaired by the contractors.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—A report from Orange City, Fla., states that the old De Land & Atlantic grade has been selected from Lake Helen to De Land. From De Land the line will extend in a westerly direction cross the St. John's River near Crow's Bluff, and connect with the South Florida R. R. two miles south of Sanford.

RALEIGH & WESTERN.—It is reported that most of the heavy grading has been completed and two-thirds of the bridges have been finished on the extension from Gulf to Ashboro, N. C., a distance of 50 miles. It is expected to have the entire line ready for operation within six months. Pres., S. A. Hennsey, Egypt, N. C.

RUTLEDGE & ST. JULIAN.—It is proposed to extend this road 22 miles next year to open up the territory between the Alabama Midland Ry. and the Louisville & Nashville R. R. The line is now completed from Julian to Rutledge, Ala., a distance of 3½ miles. Pres., J. W. Ivey, Petrey, Ala.

TENNESSEE CENTRAL.—This company proposes to construct a railway from Standing Stone, Tenn., the present terminus of the Nashville & Knoxville R. R., through Crossville and Crab Orchard to connect with the Cincinnati Southern Ry. at Rockwood or Harriman. Cumberland county is asked to subscribe for $50,000 of the stock, payable in county bonds, and the terminal city selected for a similar amount.

Projects and Surveys.

POWELL'S MOUNTAIN MINERAL.—Incorporated in Tennessee to construct and operate a railway from near the mouth of Big Sycamore Creek, in Claiborne county, northeast through Hancock county to the Virginia state line, and through Lee and Scott counties, Va., to a connection with South Atlantic & Ohio Ry. between Clinch Port and Big Stone Gap, in Wise county, Va. L. M. Jones, H. F. Coleman, A. J. Tyler, D. F. Bailey, Joshua Davis, W. T. Wolffe, W. B. Davis, C. H. Coleman, Sampson Williams, T. J. Harrison, B. J. Drinnor.

Northwest—Existing Roads.

AHNAPEE & WESTERN.—Grading and bridge building has been commenced on the extension from Ahnapee, Wis., to Sturgeon Bay, a distance of 20 miles, and it is expected to have the road completed by early spring. Pres., E. Decker, Ahnapee, Wis.

RED RIVER VALLEY & WESTERN.—This company was incorporated in July, and the contract for building the first 12 miles of the road from Addison, N. Dak., west through Sharon to Lynchburg, was awarded to Foley Brothers & Guthrie, St. Paul. The tracklaying is now reported to have been completed and the line will be operated by the Great Northern Ry.

WISCONSIN, MINNESOTA & PACIFIC.—The U. S. circuit court has ordered the sale of this railway, about 218 miles in length, all in Minnesota. Pres., L. C. Mitchell, Minneapolis.

Projects and Surveys.

MIDLAND PACIFIC.—It is reported that efforts are being renewed to secure the construction of this road from Sioux Falls, S. Dak., to Pierre, a distance of 221 miles. Some four years ago the line was surveyed and the city of Sioux Falls voted $120,000 of bonds in aid of the project. A large amount of the construction bonds is also reported to have been subscribed for. Pres., R. F. Pettigrew, Sioux Falls, S. Dak.

MISSISSIPPI RIVER & LEECH LAKE.—The citizens of Little Falls, Minn., have voted $100,000 to aid this proposed railway from that city to connect with the Great Northern Ry. at St. Cloud. The road is expected to cost $300,000 and it is reported that Peter Musser, Pres. Pine Tree Lumber Co., Little Falls, and Frederick Weyerhauser, St. Paul, will raise the remaining $200,000.

Southwest—Existing Roads.

LA PORTE, HOUSTON & NORTHERN.—Tracklaying on the extension of this road from Harrisburg, Tex., to La Porte, a distance of about 17 miles, was commenced at Harrisburg last week and is expected to be completed Nov. 15. We noted the purchase of 4,000 tons of steel rails, in our issue of Sept. 14.

MISSOURI PACIFIC.—This company will lay about five miles of track this fall at the Cypress yards, Kansas City, Kan. Over 250,000 cu. yds. of grading have been done preparatory to laying the new switch tracks.

TEXAS MIDLAND.—The construction of 40 miles of extensions has been authorized by the stockholders of this company, as previously stated in these columns. The work will be commenced as soon as possible, the three-mile extension from Garret, Tex., to Ennis probably being the first one built.

Projects and Surveys.

KANSAS, OKLAHOMA CENTRAL & SOUTHWESTERN.—Senator Martin of Kansas has introduced a bill in the senate granting this company the right of way through the Indian Territory and Oklahoma.

MYRTLE SPRINGS SHORT LINE.—This company was incorporated last spring to build a railway from Myrtle Springs, Tex., to a connection with the Texas & Pacific R. R. in Van Zandt county. E. A. Shaver, Pittsfield, Mass., one of the incorporators, is reported to have contracted for the construction of the road, the line to be completed within six months. The right of way has already been secured and cleared ready for the graders. Ch. Engr., T. J. McKain, Wills Point, Tex.

OKLAHOMA.—A press report from Pawnee, Okla., states that a route is being selected for a railway from Coffeyville, Kan., through Stillwater, Okla., to Guthrie.

TEXAS.—Last week we noted the revival of the project for a railway from Brownsville, Tex., up the Rio Grande Valley to Laredo. The idea of a railway from Brownsville to Corpus Christi is now being considered and a proposition has been received by the citizens of Cameron and Hidalgo counties for the early construction of the road by Maj. S. G. Miller and others, of New York, according to reports. A committee has been appointed at Brownsville to secure the desired bonus. Address J. I. Peters, Cy. Engr., Corpus Christi, Tex. A meeting has been held at Oakville, Tex., to consider a proposition of a Cuban syndicate to build a railway between that city and San Antonio, through Pleasanton. C. O. Orrick and E. Wimmer are members of the committee from Live Oak county to meet delegates from other counties to consider the proposition.

Rocky Mt. and Pacific—Existing Roads.

ALBERTA RY. & COAL CO.—The owners of this road are reported as trying to dispose of the present rolling stock on the ground that the railway is to be changed to standard gage. The line extends from Dunmore, Assiniboia, through Alberta to the international boundary line, a distance of 174 miles, where it connects with the Great Falls & Canada, which extends to Great Falls, Mont., a distance of 133 miles. Both roads are laid with 28 to 35-lb. steel rails and are 3-ft. gage. Pres., A. T. Galt, Montreal; Gen. Supt., W. D. Barclay, Lethbridge, N. W. T.

BUTTE, ANACONDA & PACIFIC.—A press report states that this railway has been completed between Butte, Mont., and Anaconda, a distance of about 25 miles. Bonds for $3,000,000 have been sold and surveys made for a continuation of the line, as stated in our issue of Aug. 3.

CANADIAN PACIFIC.—Harry Abbott, Gen. Supt., Vancouver, B. C., is reported as in the Caribou country investigating the feasibility of constructing a narrow gage railway from the main line through Lillooet to Barkerville. The Caribou country is claimed to be rich in gold mines, and the proposed railway will doubtless receive generous grants from the government. It is believed that the preliminaries will soon be arranged and construction of the road commenced in the spring.

COOS BAY, ROSEBURG & EASTERN.—A report from Portland, Ore., states that the remaining 62 miles of this railway from Myrtle Point to Roseburg have been located. Work has been practically suspended for the season, but will be resumed in earnest in the spring and the entire road probably completed by Nov. 1, 1894. The track laid is being ballasted and trains are run from Marshfield to Myrtle Point, a distance of about 26 miles, twice a week.

DENVER, LAKEWOOD & GOLDEN.—Boulder capitalists are reported as trying to secure an extension of this railway from Golden, Colo., to that city. Pres., C. C. Welch, Denver, Colo.

NATIONAL CITY & OTAY.—This company has just completed a little over a mile of new railway, leaving the Sweetwater Branch at Canyon Junction, Cal., and following the Sweetwater River into the Canyon quarry immediately below the Sweetwater dam. The rock thus made available will be used at once in building the government jetty now under construction at the entrance to San Diego harbor. Ch. Engr., H. N. Savage, National City, Cal.

SAN DIEGO, YUMA & PHOENIX.—Work on this road was suspended recently after laying about 3½ miles of track, as stated in our issue of Sept. 28, but it is now reported that the work will soon be resumed again. W. H. Carlson, mayor of San Diego, Cal., has been elected president of the company in place of D. C. Reed, resigned.

Projects and Surveys.

HELENA & SOUTH MOUNTAIN.—The contract for grading 36 miles of this railway, between Whitehall, Mont., and Sheridan, has been awarded to James Brown, Butte, Mont., according to reports. The company was incorporated about a year ago by Samuel Ward, Helena, and others, to build a road from Helena to Dillon, a distance of 150 miles. The road will pass through gold mining districts and it is stated that its construction will be pushed as rapidly as possible.

UTAH & WYOMING.—Two corps of engineers are at work surveying the route for this proposed railway from Casper, Wyo., to Ogden, Utah, one being in Uinta county, near Willow Creek gap, and the other between Fossil and Nugget on the direct Oregon Short Line survey. The survey is expected to be completed about Feb. 1.

Foreign.

MEXICO.—A dispatch to the St. Louis "Globe-Democrat" from the city of Mexico states that the concession granted to James Sullivan, in May, 1892, for the construction of the Colima & Guadalajara R. R. and the other lines covered by the concession to the Mexican National Construction Co. of July 5, 1888, has been modified by the extension of the time for completion of the Colima & Guadalajara line to June 7, 1897, and of the other to June 5, 1892. The concession for the San Marcos & Nautla R. R., granted to Felipe Martel on June 8, 1890, has just been referred as follows: The line is to be completed within nine years of date of promulgation of this decree; 50 kilometers at least of railway, in addition to the 76 already finished, must be constructed by July 4, 1896, and in each succeeding term of two years 50 more, so that the entire line is finished by the time stipulated. The department will pay the $6,000 subsidy on the completed kilometers at the end of each fiscal year.

SYRIA.—A press dispatch from London states that the contract for building the railway from Haifa, in Syria, to Damascus has been awarded to a Chicago firm. The equipment, engines and cars will probably be of American make. The contractors will sail for Haifa on Oct. 18, and will immediately begin work. They expect to complete the road in 18 months. The project contemplates an ultimate extension of the road to India if Persian concessions can be obtained.

STREET RAILWAYS.

NATICK, MASS.—The Natick & Cochituate Ry. Co. has purchased 56-lb. rails to relay its track in Felchville. It is understood that further improvements will be made in the spring.

NEWTON, MASS.—The Newton St. Ry. Co. is reported as planning to build another short extension in Waltham next spring.

BATAVIA, N. Y.—J. W. Holmes, Batavia, is surveying a route for the proposed extension of the electric railway from Buffalo to Depew to this place.

KINGSTON, N. Y.—It is stated that the construction of the projected Colonial City Electric Ry. will be commenced within a few days. Goodwin & Swift, New York, are the promoters of the enterprise.

PATERSON, N. J.—Press reports state that a syndicate is negotiating for the right of way for an electric railway between this city and New Brunswick by way of Plainfield. The road would probably be extended from New Brunswick to Philadelphia and from

this city to Jersey City, and it is believed that the New Jersey Traction Co. is interested in the project.

SOUTH ORANGE, N. J.—The village trustees have granted permission to the Newark & South Orange Ry. Co. to run electric cars within the village limits. The franchise is for 25 years, the fare to be 5 cts., with a transfer system, and the village to get $100 per mile a year.

SOUTH BETHLEHEM, PA.—The Lehigh Valley Traction Co. is building a double track electric railway from Coplay to this place. The road has been completed from Allentown to Catasauqua and the right of way secured to the borough line of this village, to which place the road will be extended if the council gives its consent.

WEST CHESTER, PA.—The route for the proposed Philadelphia, West Chester & Suburban Ry., recently incorporated, has been surveyed by J. Clemson Sharpless. The distance is about 23 miles and there will be no grade of over 100 ft. to the mile.

COVINGTON, KY.—It is stated that the incorporators of the new street railway project to West Covington and Ludlow are members of the South Covington & Cincinnati St. Ry. Co.

CANTON, O.—The engine and power house together with a number of motors and trail cars of the Canton & Massillon Electric Ry. Co. were destroyed by fire Oct. 3 causing a reported loss of $100,000.

COLLINSVILLE, ILL.—The citizens are trying to raise $12,000 to secure an electric railway connection with St. Louis.

TRURO, N. S.—It is proposed to exempt from taxation for 10 years the property of any electric railway company that will construct a street railway in this place. The incorporation of a company for this purpose was noted in our issue of Sept. 21.

OUTREMONT, QUE.—The council has voted unanimously to grant the Montreal Park & Island Ry. Co. an exclusive franchise with exemption from taxation for 30 years, also to furnish the right of way. This will form a part of the company's route around the mountain and through Notre Dame de Grace, and it is thought probable that tracklaying will be commenced this fall.

HIGHWAYS.

MASSACHUSETTS.—The proposed state highway from Boston to some place in Rhode Island seems to be received with much favor. The citizens of Walpole have petitioned for another town meeting to discuss the matter.

TEXAS.—The citizens of Denison are planning for a wagon road from that place to Kentuckytown.

BRIDGES AND TUNNELS.

LOWELL, MASS.—The street committee is considering the construction of a new bridge across the Concord River at East Merrimack St., the work to be done this fall.

WARE, MASS.—The town has appropriated $2,000 for a new iron bridge.

LONG ISLAND CITY, N. Y.—The supervisors of Queens county have voted in favor of a tunnel under Newtown Creek to connect this city with Greenpoint, and the question is now being considered by the bridge committee of Kings and Queens counties. Plans for a tunnel, prepared by Supervisor Koehler, estimate the cost at $750,000, and it is thought that the work can be completed by 1895.

ATLANTA, GA.—The city is considering plans for connecting the west side of the city and the central portion. Both tunnels and bridges are proposed.

TWO RIVERS, WIS.—Bids were opened Sept. 29 for a 170-ft. swing span bridge, with stone center pier, protection pier and stone abutments, all stone work to rest on pile foundations, and the city to furnish all piles. The bids were as follows: Variety Iron Works, Milwaukee, $14,450, as per specifications, or $10,500 without abutments; Youngstown Bridge Co., $14,900, or $10,500; Milwaukee Bridge and Iron Works, $14,975, or $10,240; Wisconsin Bridge & Iron Co., $14,529, or $9,975, or $11,027 substituting pile abutments; Penn Bridge Co., $8,000 for superstructure and $11,500 for substructure; Chicago Bridge & Iron Co., $15,575, as per specifications, or $9,800 without abutments. The last bid not containing a certified check was not considered, and the contract was awarded to the Wisconsin Bridge Co. at $11,000, pile abutments to be used. Engr., Oscar Sanne, Milwaukee.

LITTLE ROCK, ARK.—The Little Rock Bridge & Terminal R. R. Co. has made a proposition to the Pulaski county levying court to build a bridge across the Arkansas River at this place. The bridge would be completed within 18 months, and the county would be given free use of the bridge, and is asked to pay $200,000 toward its construction. It is reported probable that the proposition will be accepted. Pres., W. G. Dacy, New York.

WATER-WORKS.

LYDONVILLE, VT.—The village is in favor of putting in the proposed works, but the question of raising the necessary funds has not yet been decided.

FALL RIVER, MASS.—The commissioners have been directed to secure estimates for a new pumping engine.

NEWPORT, R. I.—Plans have been prepared for a new main 6,000 ft. long. The work will be done this fall.

WOONSOCKET, R. I.—The commissioners have reported that an additional storage reservoir should be constructed at once.

NEW YORK, N. Y.—Bids are asked until Oct. 23 for cast iron pipe and special castings. M. T. Daly, Comr. Pub. Wks.

POUGHKEEPSIE, N. Y.—The board has recommended the construction of new filter beds at a cost of $40,000.

JERSEY CITY, N. J.—The commissioners have invited the finance committee to a consultation, no date specified, to consider the different plans for a supply.

PITMAN GROVE, N. J.—A resident of Philadelphia who has a cottage here has made a proposition to build works.

SOUTH AMBOY, N. J.—A contract has been made for a supply for five years from Perth Amboy, at 7 cts. per 1,000 gallons, and is ready for the approval of the mayors of the two cities.

ALLEGHENY, PA.—Mayor Kennedy is anxious that more rapid progress should be made in securing a better supply. It is stated that the present supply is not sufficient to flush the sewers as regularly as should be.

BENNETT, PA.—The council of Millvale borough has appropriated $64,000 for works, for which the contract was recently awarded.

CONNELLSVILLE, PA.—Work will soon be commenced by the H. C. Frick Coke Co. upon the proposed works on the Youghiogheny River above this place.

SHENANDOAH, PA.—A preliminary injunction has been granted restraining the borough from building a reservoir in West Mahanoy township. It is claimed that its location would endanger mine property and the lives of the miners.

WILMINGTON, DEL.—J. A. Bond, Ch. Engr., will receive bids for hauling 1,000 tons of gravel and sand for the filter beds.

ANNAPOLIS, MD.—A meeting of the Annapolis Water Co. was held Oct. 10 to consider plans for improving the supply. Last summer R. K. Martin, Baltimore, reported that the plant was being run to its fullest capacity at that time, and he suggested that a 16-in. pipe be laid from the reservoir to the city, a distance of about four miles; estimated cost, $90,000.

LONACONING, MD.—The proposition to issue bonds for $30,000 for works was defeated by a vote of 104 to 64.

WASHINGTON, D. C.—It is proposed to ask for an appropriation of $20,000 for testing the Lydecker tunnel, which was commenced some ten years ago and partially completed. The test would last from nine to 12 months. A board of experts reported that the tunnel could be completed and a 6-ft. steel pipe placed in it for $852,786.

HARRISONBURG, VA.—An election will be held to vote on an issue of bonds for $18,000 for an additional supply from springs less than two miles distant.

LURAY, VA.—L. H. Keller, Mayor, writes us that the city wishes propositions for works; population, 3,000.

PETERSBURG, PA.—The city engineer has reported plans for a new supply; estimated cost, $90,000 to $169,000, according to plan.

ELKINS, W. VA.—We are informed that contracts will probably be awarded in the spring for works to be put in by a private company; estimated cost, $20,000; population, 1,500.

GAINESVILLE, FLA.—J. W. Patton and S. H. Wienges are surveying for the proposed main to Boulware springs.

SCRANTON, MISS.—An artesian well having a daily capacity of about 60,000 gallons has been completed, and the question of works is now being considered.

ELMWOOD PLACE, O.—An election will be held Nov. 7 to vote on an issue of bonds for $30,000 for works and an electric light plant.

TOLEDO, O.—The committee has sold $450,000 of water-works bonds.

JACKSON, MICH.—An election will be held Oct. 23 to vote on an issue of bonds for $20,000 to extend the mains.——The committee wishes two new boilers for the pumping station.

SAGINAW, MICH.—It is reported that the council has authorized the issue of $25,000 of 20-year bonds for extensions.

TREMONT, ILL.—The Tremont Water-Works Co. has been incorporated by J. Velde, A. D. Davis and others to put in works; capital stock, $3,500.

POPLAR CREEK, MONT.—Bids will soon be asked for works, at Fort Peck Agency, including windmill and tank. Capt. H. W. Sprole, U. S. A.

OREGON, MO.—The citizens are in favor of issuing bonds for works, according to reports.

ST. JOSEPH, MO.—The council wishes larger mains in several streets and an additional main to the reservoir.

EDDY, TEX.—An artesian supply of 1,000,000 gallons daily has been secured and works will now be put in. P. P. Kincannon, Pres.

LAFAYETTE, COLO.—The town board has decided to increase the size of the reservoir and put in a new filter.

CASTLE ROCK, WASH.—The council is considering a proposition from Portland and Tacoma parties to put in works.

ANAHEIM, CAL.—The Anaheim water district is receiving bids for $200,000 of bonds.

LOS ANGELES, CAL.—The Baldy Mountain Land & Water Co. has been incorporated by Albert Haentze, Chicago; Henry Newby, Pasadena; D. P. Hatch and others; capital stock, $250,000.

LUNENBURG, N. S.—J. A. Piggott, New Glasgow, is engineer of proposed works.

HEDLEYVILLE, QUE.—The contract for works has been awarded to E. L. de la Vallee & Co., Montreal, at $49,500.

WINDSOR, ONT.—Bonds for $55,000 are proposed to extend the mains above Walkerville.

IRRIGATION.

PORTLAND, ORE.—Bids are asked until Nov. 1 for the completion of about 16 miles of the canal of the Oregon Land, Irrigation, Lumber & Fuel Co., situated in the south end of Wasco county, 70 miles east of Portland, by Barlow road. The job is mostly scraper work, and will be divided into five divisions. Geo. W. McCoy, Secy., 284 Morrison St.

NEW COMPANIES.—Sacramento County Irrigation Co., Sacramento, Cal.; $1,000,000; J. A. Merrill, A. R. Dow, Oakland; S. R. Thomas and others, San Francisco.——Republican River Irrigation Co., Benkelman, Neb.; $2,000.——Three Mile Falls Ditch Co., Pendleton, Ore.; $1,000.

SEWERS.

PORTSMOUTH, N. H.—The question is again being discussed. The mayor is reported as opposing any appropriation until plans for a complete system have been prepared.

EVERETT, MASS.—The council has voted to issue $10,000 of 6% sewer bonds.

LAWRENCE, MASS.—The $50,000 loan ordinance is ready for the mayor's signature. If this is refused it is proposed to transfer $30,000 from other departments for this work.

JAMESTOWN, N. Y.—The following bids were received Oct. 3 for about 45,000 lin. ft. of sewer: Rider & Fitzgerald, Dunkirk, $55,666; W. J. Dunn, Pittsburg, $66,691; Wm. Franklin, Buffalo, $60,855; A. C. Curtis & Co., Hoosick Falls, $67,944; W. H. Roberts, Pittsburg, $71,276; F. E. Gibbens, Youngstown, $86,281.

NIAGARA FALLS, N. Y.—The Cataract Construction Co. has awarded the contract for the building for its sewage disposal plant to B. P. Smith, Rochester, at about $20,000. Mr. Smith has the contract also for constructing the system, as stated in our issue of Sept. 14.

JERSEY CITY, N. J.—The proposed sewer recently referred to will include 7,000 lin. ft. 48-in. brick sewer and 3,200 lin. ft. 18-in. pipe sewer, average cut 10 ft. The time for receiving bids for the work has not been decided upon. W. W. Ruggles, Ch. Engr.

NEWARK, N. J.—Bids are asked until Oct. 18 for three sewers. Chas. Marsh Supt. Wks.

BRUSHTON, PA.—The council has decided to spend $50,000 for a system, and an election will soon be held to vote on an issue of bonds for this purpose.

LEBANON, PA.—The city engineer has been directed to prepare plans for a sewer estimated to cost $6,000.

READING, PA.—The city will vote on a loan of $600,000 for sewers and streets next month.

BALTIMORE, MD.—The special committee has submitted a report, and the mayor has recommended an appropriation of $5,000 for continuing the investigation.

TOLEDO, O.—Work will soon be commenced on nine sewers, and contracts will soon be awarded for several others.

ANN ARBOR, MICH.—Bids are asked until Nov. 6 for $30,000 of sewer bonds. Wm. J. Miller, Cy. Clk.

PONTIAC, MICH.—The question of a complete system of sewers and a better method of sewage disposal is being discussed by the council.

CHICAGO, ILL.—The city will soon construct several important sewers, including $250,000 of work that it was intended to postpone until next year.

LINCOLN, ILL.—Bids are asked until Oct. 16 for two 36-in. brick sewers. Frank Bollin, Cy. Clk.

MILWAUKEE, WIS.—Bids will be opened in about three weeks for 2,500 lin. ft. of 10-ft. brick sewer, in tunnel; estimated cost, $55,000. G. H. Benzenberg, Cy. Engr.

SIOUX CITY, IA.—The time for receiving bids for sewers recently advertised has been extended from Oct. 10 to Oct. 24. T. H. Johnson, Cy. Engr.

MINNEAPOLIS, MINN.—The city has ordered sewer work for next year estimated to cost $189,000.

STREETS.

LEOMINSTER, MASS.—The town will hold a special meeting to vote on a proposition to build new streets and sewers so as to give work to unemployed.

ALBANY, N. Y.—The board of contract has confirmed about $75,000 of paving apportionments.

BUFFALO, N. Y.—The department of public works will receive bids until Oct. 21 for paving five streets with asphalt, Medina stone or brick.

NEWARK, N. J.—Bids are asked until Oct. 18 for paving about 26,800 sq. yds. with stone blocks, seven contracts. Chas. Marsh, Supt. Wks.

PHILADELPHIA, PA.—According to the Philadelphia "Press" the street railway companies will lay about 60 miles of paving this year, 60% being asphalt and 40% Belgian blocks. The railway companies have about 290 miles to pave, estimated to cost $20,000,000, and the city 450 miles. The city will have spent about $1,300,000 this year for repaving.

BALTIMORE, MD.—The mayor has appointed a commission to investigate the cost of paving in this city and other large cities. Jas. Hodges and Chas. Goldsborough are members.

CINCINNATI, O.—The Trinidad Asphalt Co. has been awarded the contracts for paving Straight St. and Fairview Ave., at $16,441 and $55,042 respectively.——Kolthoff & McCarren bid $76,568 and J. Boland $80,492 for improving Columbia Ave. The estimate is $73,774, and the contract was not awarded.

TOLEDO, O.—The following bids were received for paving Junction Ave., the first price being for berea curb and the second for Medina curb: W. McMahon, brick, $8,069, $8,365; cedar blocks, $7,208, $7,594; C. W. McKinney, brick, $8,678, $8,950; cedar, $7,879, $8,151; G. H. Bodette, brick, $8,804, $9,097; cedar, $7,639, $7,932; I. C. Wernert, brick, $10,034, $10,282; cedar, $8,675, $8,922; P. Koster and L. Burkhardt, brick, $11,985, $12,256; no bid for cedar.

MINNEAPOLIS, MINN.—The city engineer has prepared plans for tunneling under the tracks of the Chicago, Milwaukee & St. Paul Ry.; estimated expense, $500,000.——The council has ordered $140,000 of paving for next year.

DENVER, COLO.—For paving Nineteenth St. the Colorado Paving Co. bid $45,588 and the Blake Asphalt Co. $48,924; estimate, $51,010.——Plans have been prepared for $150,000 of additional work.

ELECTRIC LIGHT AND POWER.

PAWTUCKET, R. I.—Bids are asked until Oct. 23 for lighting the city for three years. Fred. Binford, Chn. Com.

LURAY, VA.—L. H. Kellar, mayor, writes us that the city wishes bids for 15 arc and 500 incandescent lights; population, 3,000.

JACKSON, MISS.—Bids are asked for a complete electric light and power plant. A. H. Kirkland.

MILLDALE, KY.—A franchise has been granted to the Milldale & Central Covington Electric Light Co., the town to be given three arc lights free for three years.

HAMILTON, O.—The council has voted in favor of issuing bonds for $50,000 for an electric light plant, subject to a vote of the people.

SACRAMENTO, CAL.—The Sacramento Electric Power & Light Co. has contracted with the General Electric Co. for its plant for the transmission of power from Folsom to this city, a distance of 19 miles. The poles are to be 40 ft. in length and the wires suspended 30 ft. from the ground. The work will require 500,000 lbs. of copper wire.

NEW COMPANIES.—Wenstrom Electric Co., Baltimore, Md.; $1,000,000; J. P. Smith, Enoch Pratt, Jacob Torne, Robt. Rennert.——Pullman Electric Co., Chicago, Ill.; $25,000; F. A. Pullman, J. M. Atkinson, David Reid.——Fuliner-Danhoff Electric Co., Chicago, Ill.; $5,000,000; Franz Fuliner, A. B. Coon, H. A. Gates, W. B. Keeps.——West Chicago Light & Power Co., Chicago, Ill.; $60,000.——Wabaska Electric Co., Wymore, Neb.; $25,000.——Des Moines Rapids Power Co., Hamilton, Ill.; $500,000.

CONTRACT PRICES.

ARTESIAN WELL.—Baker City, Ore.—The county court of Harney Co. has contracted with Geo. W. Kellogg, Salt Lake City, for a 6-in. artesian well, to be 500 to 1,500 ft. deep, at $2.75 per lin. ft., including casing.

DREDGING.—Portland, Me.—The following bids were received for dredging 150,000 cu. yds. in Harrasecket River: A. B. Martin, Boston, 28 cts. per cu. yd., measured in scow; C. H. Souther, Boston, 25 cts.; Moore & Wright, Portland, 17½ cts.; Hamilton & Sawyer, Chebeague, 25½ cts.; Charles W. Anthony, Fall River, Mass., 21.9 cts.

PIPE.—Washington, D. C.—Bids for cast iron pipe ranged from $21.75 to $23.79 per gross ton delivered on wharf, or $22.10 to $27.10 on cars.

HIGH DUTY PUMPING ENGINE.—Providence, R. I.—The following table gives a comparison of the bids received by J. Hebert Shedd, Cy. Engr., on Aug. 31 for a high-duty pumping engine plant for the low service of the Providence water-works. Bidders were notified that a proper allowance would be made in favor of engines for which a duty above 100,000,000 was guaranteed. The comparison is made on the basis that the annual cost of each engine to the city will vary solely with its first cost and with its rate of guaranteed duty, which it was assumed would be maintained in regular service. The contract was awarded to Henry R. Worthington, as stated in our issue of Sept. 21.

Comparison of Bids for Engine-Plant for Providence Water-Works to Pump 15,000,000 Gallons of Water Daily Against 180 ft. Head.

Name of Bidder.	Kind of engine.	Sum of bids.	Guaranteed duty.	Annual interest on bid at 4%.	Annual cost of coal at $5 per ton in furnace for 15,000,000 gals.	Sum of last two—annual cost of variable expenses.	Steam pressure Lbs.	Time to build, in months.
Edward P. Allis Co., Milwaukee, Wis.	Vert. comp.	$75,000	105,000,000	$3,000	$19,554	$22,554	125	8
	" "	65,000	105,000,000	2,600	19,554	22,154	125	7
Henry R. Worthington, New York, N. Y.	Vert. comp.	63,500	105,000,000	2.540	19.554	22.094	125	8
	" "	73,000	110,000,000	2,920	18,664	21.584	125	8
	Vert. Trip. Exp.	70,100	120,000,000	2,800	17,109	19,909	125	8
	" " "	79,000	125,000,000	3.160	16.425	19.585	155	8
Holly Mfg. Co., Lockport, N. Y.	Vert. comp.	64,327	110,000,000	2,573	18,664	21,237	110	10
	" "	61,360	105,000,000	2,454	19,554	22,008	110	10
Groshon Pumping Engine Co., New York, N. Y.	Vert. comp.	84,500	115,000,000	3,380	17.853	21,233	125	10
	" "	80,000	115,000,000	3,200	17,853	21,053	125	10
	Vert. Trip. Exp.	92.500	125,000,000	3,700	16,425	20.125	150	10
	" " "	88,000	125,000,000	3,520	16.425	19.945	150	10
Geo. F. Blake Mfg. Co., Boston, Mass.	Cross Comp.	*52.787	115,000,000	2,111	17.853	19,965	125	

* $4,500 added for uniform boiler comparison.

BRICK AND ASPHALT PAVING.—Erie, Pa.—A contract for paving with asphalt has been awarded to H. Mayer, at $1.98 per sq. yd.; total, about $3,485. The bids for paving this with vitrified brick ranged from $1.20 to $1.50 per sq. yd., with excavation at 25 to 40 cts. per cu. yd. and ballast at 50 to 55 cts. per cu. yd., making the total cost for brick about the same as for asphalt, according to the estimate of the committee.

DRAINAGE CANAL.—Chicago, Ill.—Bids were opened Oct. 4 for the reletting of sections 2, 3 and 4 of the drainage canal, being about three miles just below Willow Springs and including the excavation of 1,484,793 cu. yds. of solid rock and 2,179,524 cu. yds. of glacial drift. The work was let to McArthur Bros., about a year ago, at 27 cts. per cu. yd. for glacial drift and 86 cts. for solid rock, but last April it was discovered that a large portion of the glacial drift consisted of a hard clay which resisted all ordinary efforts at excavation. The refusal of a solid rock price for this work resulted in a discontinuation of the work and its being readvertised. The press reports state that the lowest bids on sections 2 and 4 were those of McKeown, Stowell & Co., at 48 and 84 cts. per cu. yd. respectively for glacial drift and for rock on section 2, and 46 and 84 cts. for section 4. C. C. Gilman was the lowest on section 3, at 46 and 76 cts. respectively. The total bids received are given as follows, the bid of McArthur Bros. being added for comparison:

Section 2.

McArthur Bros. (last year)	$640,089
McKeown, Stowell & Co., Buffalo, N. Y.	773,970
Mason, Hoge & Co., Frankfort, Ky.	798,201
Dawson, Symines & Co., Chicago	816,193
F. H. Clement, New York	887,153
Strong & Lee, New York	919,687
Christie & Lowe, Chicago	971,751
Ezekiel Smith, Chicago	1,030,781

Section 3.

McArthur Bros. (last year)	$647,016
C. C. Gilman, Marshalltown, Ia.	778,550
Sinclair Construction Co., Chicago	793,952
McKeown, Stowell & Co., Buffalo, N. Y.	804,675
Christie & Lowe, Chicago	808,183
F. H. Clement, New York	809,759
Mason, Hoge & Co., Frankfort, Ky.	859,458
Strong & Lee, New York	870,494
Dawson, Symines & Co., Chicago	941,252
Ezekiel Smith, Chicago	979,237
Winslow Bros. & Stevens, St. Paul	1,112,396

Section 4.

McArthur Bros. (last year)	$778,311
McKeown, Stowell & Co., Buffalo, N. Y.	849,345
Mason, Hoge & Co., Frankfort, Ky.	874,114
Dawson, Symines & Co., Chicago	910,000
Strong & Lee, New York	990,377
F. H. Clement, New York	1,013,529
Ezekiel Smith, Chicago	1,153,439
McMahon & Montgomery Co., Chicago	1,993,251

MISCELLANEOUS CONTRACTS AND SUPPLIES.

STREET SWEEPER.—Ashtabula, O.—It is reported that the council may purchase a street sweeper.

BULKHEAD.—San Francisco, Cal.—The contract for bulkheading Lewis St. has been awarded to Warren & Malley, at nearly $200,000.

PILE DRIVING.—Providence, R. I.—The third contract for foundation work on the cove has been awarded by the New York, New Haven & Hartford R. R. Co. to Joseph Ross, Boston, at about $18,000.

PUBLIC BUILDING.—Milwaukee, Wis.—The contract for the superstructure of the federal building to be erected in this city has been awarded to C. B. Roberts, Milwaukee, at $340,672, Hallowell granite to be used.

DRAINAGE.—Colville, Wash.—The scheme to drain the Colville valley by forming a drainage district and issuing bonds is reported as meeting with public favor, and the movement will begin with a petition to the county commissioners at its meeting this month. There will be over 20,000 acres included in the drainage district when organized.

TRACKS.—National City, Cal.—Bids are invited for constructing a regulation mile race track and a 4-lap bicycle track at Sweetwater Park, five miles from the city of San Diego. Plans have been approved for a park at that place and all the necessary buildings will be constructed at once. H. N. Savage, Engr. and Supt. Construction.

LOCK GATES.—Ottawa, Ont.—The contract for five pairs of lock gates for the Sault Ste. Marie Canal has been awarded to Hugh Ryan, at about $70,000, according to reports. Mr. Ryan completed the masonry on the lock walls Oct. 2. The itemized bids received by Col. O. M. Poe, U. S. Engineer Office, for lock gates were published in our issue of Sept. 28.

CANAL.—Omaha, Neb.—The commissioners of Douglass Co. have taken steps toward aiding the Platte River canal project by voting to employ the county engineer and city engineer of this city to examine the plans of the company, measure the volume of water in the Platte and Elkhorn rivers, and study the topography of the country through which it is proposed to construct the canal.

PUMPING PLANT.—Detroit, Mich.—The following bids were received by Col. O. M. Poe, U. S. Engineer Office, for pumping plant of the 800-ft. lock, St. Mary's Falls Canal: Southwark Foundry & Machine Co., Philadelphia, centrifugal pumps, $24,935; Macintosh, Hemphill & Co., Pittsburg, $35,000; Morgan Engineering Co., Alliance, O., $46,775; Westinghouse, Church, Kerr & Co., New York, driving machinery, $16,375; Manning, Maxwell & Moore, New York, $16,912; Morgan Engineering Co., $17,485; Babcock & Wilcox Co., New York, Babcock & Wilcox boilers, $47,574; Manning, Maxwell & Moore, $48,935.

INDUSTRIAL NOTES.

RIEHLE BROS. TESTING MACHINE CO., of Philadelphia, report orders for a 100,000-lb. testing machine for Schoenberger & Co., one 40,000-lb. testing machine for Shelby Steel Tube Co., one 20,000-lb. horizontal testing machine for J. Painter & Sons Co., and one 10,000-lb. vertical machine for Prof. A. N. Talbot, University of Illinois, Champaign, Ill. A number of other orders for testing machines of smaller sizes have recently been booked and the company considers that a steady improvement in business conditions is in progress.

L. SCHUTTE & CO., engineers and machinists, Philadelphia, Pa., have at the World's Columbian Exposition an exhibit of boiler appliances, etc., including the Korting universal double tube injector for locomotive and other boilers, the automatic eductor (or ejector operated by a water jet), steam jet siphons for raising water, blowers and ventilators, steam traps, valves, etc.

THE BUCKEYE ELECTRIC CO., of Cleveland, O., announces that it will manufacture the Buckeye incandescent lamp under new and non-infringing patents, the cost of 16-c. p. lamps being 42½ cts. each in lots of 100 or 37½ cts. in lots of 200. A coiled filament is used, and the lamp is claimed to have a long life, low operating cost and excellent lighting effect. The Buckeye lamp has been on the market for some time and has been very successful.

THE LIDGERWOOD RAPID UNLOADER, described in our issue of April 18, 1891, and Oct. 6, 1892, is now in use by four large contracting firms and seven important railway companies, as follows: Drake & Stratton Co. (seven), Smith & Hanfield (two), Adirondack & St. Lawrence Ry. Co. (three), Terminal R. R. Assoc. of St. Louis (one), Lake Shore & Mich. Southern R. R. (one), Lehigh Valley R. R. Co. (one), Lake Erie & Western R. R. Co. (one), Penns. R. R. Co. (one), Boston & Albany R. R. Co. (one), Standard Lime & Stone Co. (two), and Cahill, Collins & Co. (one). One is also in use by the Cleveland Iron Mining Co.

THE VULCAN IRON WORKS, of St. Louis, Mo., built at a cost of $1,000,000, and covering six acres of ground, is being sold piecemeal as junk. The 8-ton steam hammer was sold to Pittsburg parties for $6,000. Even the brickwork is disposed of to wreckers. When in operation the works employed 2,800 men, but its machinery was not up to a modern standard, and the big strike of 1882 ended its career.

NEW COMPANIES.—Ronceverite Oil Co., Ronceverite, W. Va.; Chicago Contract Co., Charleston, W. Va.; MacDonald Contract Co., MacDonald, W. Va.; Weston Natural Gas & Fuel Co., Weston, W. Va.; Sinclair Construction Co., Chicago, Ill.

SOUTH MILWAUKEE WATER-WORKS.

Bids will be received until 5 o'clock p. m. Saturday, October 21, 1893, by the Water-Works Committee of the Village of South Milwaukee, Wis., at the office of Dousman & Sheldon, Engineers, Room 414 Matthews Building, Milwaukee, Wis., for the following material to be delivered f. o. b. at South Milwaukee, and work to be done upon the South Milwaukee Water-Works.

1. Two compound duplex condensing pumping engines, each engine to have a capacity of 75,000 gals. U. S. per 24 hours pumped against 300 ft. head, to run to a pressure of 150 lbs. per square inch in case required, piston speed at later pressure not to exceed 100 ft. per min. Contract to include foundations, equipment of fittings from feed well to connection with force main (10-inch) outside wall of building, also two return flues, tubular boilers, settings, connection with stack, and all fixtures complete in every detail.

2. (a) 52 hydrants double 2½-inch nozzle, opening to the left 6 ft. from pavement to center inlet pipe, 6 inch inlet pipe and frost covers.

(b) 27 double gate valves, provided with brass lining stem and nuts, set vertical, outside screw opening to left, iron boxes to reach grade of street; two 12-inch, eight 10-inch, seven 8-inch, ten 6-inch valves.

2 horizontal 10-inch check valves.

(c) 600 tons cast iron coated pipe; 88 T. 12-inch, 39 T. 10-inch, 120 T. 8-inch, 113 T. 6-inch, 37 T. 4-inch.

(d) 27 tons pipe specials.

(e) Flexible 12-inch pipe joints if required.

(3) Intake: Furnishing (4) special castings for submerged crib and setting same; laying about 1,350 ft. 12-inch pipe in 3 ft. trench— deeper when required for grade. Laying about 725 ft. 12-inch pipe, including the angles, one tee, two valves and crossing of Oak Creek. All according to plans and specifications at office of engineer, contractor to furnish special castings.

(4) Tank, wrought iron or mild steel, 16 ft. in diameter and 42 ft. high, upon an iron or steel trestle 80 ft. high, of 4 posts, base of posts to form a square of 44 ft. side; tank to be covered with neat iron roof and have iron stairway and hand rail from ground to circular railed platform at base of tank; foundations and contract to be taken complete by contractor; village to furnish pipe and specials. Ground, clay. A deposit or certified check for $300 to accompany all bids. Pipe and specials to be tested and guaranteed for 300 lbs. per square inch. System will be tested within 30 days after completion to a pressure of 150 lbs. per square inch.

Time to be stated when pipe can be delivered at South Milwaukee.

The Water-Works Committee reserve the right to reject any or all bids, and to increase or decrease the orders to any amount necessary. Detail specifications and drawings at office of engineers. 41-1t

PROPOSALS FOR SEWER CONSTRUCTION.

SEALED bids for building a storm water sewer on 12th, 13th, Dale and 17th streets will be received by the City Clerk of Sioux City, Iowa, until 8 o'clock p. m. Tuesday, Oct. 10, 1893.

There will be about 1,200 feet of 3 ft. 4 inch, 300 feet of 4 ft. 6 inch, and 3,300 feet of 6-foot brick sewer and about 500 feet of 12, 15 and 18-inch pipe sewer, about 50 brick inlets and 15 manholes.

Plans can be seen and specifications and bidding blanks can be obtained at the office of the City Engineer.

A bond in the sum of 40% of the amount bid, with two acceptable sureties, one to be a resident of Sioux City, must accompany each bid.

Payment will be made in "Sewer Bonds" running two, three, four and five years, bearing interest at the rate of 6%.

The right is reserved to reject any or all bids.

(Signed) KNUDE SUNDE,
38-5t Chairman Sewer Committee.